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www.phys.lsu.edu

Or contact Mimi LaValle

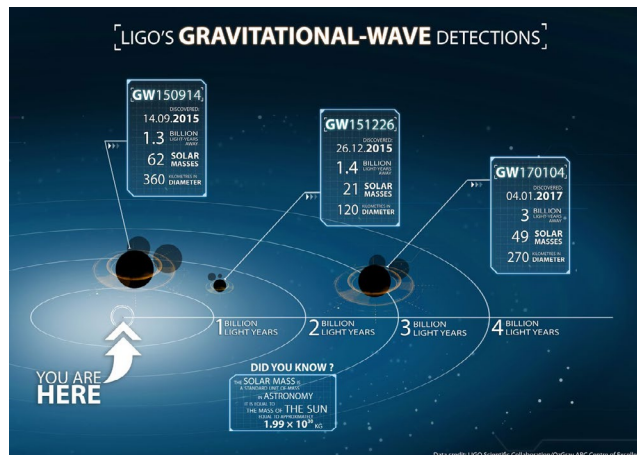
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Gravitational Waves Detected Again— Results Confirm New Population of Black Holes

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



The Laser Interferometer Gravitational-wave Observatory, or LIGO, has made a third detection of gravitational waves, which are ripples in space and time, demonstrating that a new window in astronomy has been firmly opened. As was the case with the first two detections, the waves were generated when two black holes collided to form a larger black hole.

“We are very proud of the

contributions of the LSU group to the detections of gravitational waves with LIGO detectors - this is just the beginning of a new, exciting era,” said Gabriela González, former LIGO Scientific Collaboration spokesperson and professor of physics and astronomy at LSU.

The newfound black hole, formed by the merger, has a mass about 49 times that of our sun. This fills in a gap between the masses of the two merged black holes detected previously by LIGO, with solar masses of 62 from the first detection and 21 from the second detection.

The new detection occurred during LIGO’s current observing run, which began Nov. 30, 2016, and will continue through the summer. LIGO is an international collaboration with members around the globe. Its observations are carried out by twin detectors—one in Hanford, Wash., and the other in Livingston, La.—operated by Caltech and MIT with funding from the National Science Foundation, or 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 LIGO Science Collaboration. As the only university within driving distance of LIGO instrumentation, LSU undergraduate and graduate students conduct research daily at the observatory and have been involved in the three detections thus far.

“When we detect a gravitational wave signal, I am part of the team that carefully analyzes the

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We are delighted to share news from the Department of Physics and Astronomy at LSU. This past year, my first as chair of the department, has been one filled with change, challenge, and excitement. We are excited to have four new additions to the faculty in the Fall of 2016 bringing new avenues for research and creative instruction. Our greatest challenge was probably due to

Mother Nature soon after these three new assistant professors and instructor arrived in Baton Rouge. For those of you living outside of South Louisiana, the amount of water coming from the sky during the great flood of August of 2016 was hard to imagine. Several of our dedicated staff members and postdocs had their homes and cars flooded creating damage that took months to repair. The resiliency and generosity of the P&A family shined through during that difficult time. But recover we did and it was a great year as our students, faculty and staff received so many awards, made so many

discoveries, and were awarded so many grants that choosing which ones to include in this newsletter was a difficult job. I trust you will enjoy reading through stories we have put together here and that this newsletter will help renew your connections to the P&A community.

I also wanted to take this opportunity to congratulate Boyd Professor Robert O'Connell on the occasion of his retirement from the faculty after an amazing 53 years of teaching, researching, and serving at LSU. It is difficult to fathom the changes that have occurred since he arrived on campus in 1964. Professor O'Connell has achieved much during his time here and he tells me he is not done yet. He plans to continue to be active in research adding to his legacy as an Emeritus Professor. Well done Bob and I wish you a enjoyable retirement.

Finally, I also want to congratulate Professor Gabriela Gonzalez on being elected to the National Academy of Science! Gaby joins Professor Ward Plummer (also of the Department of Physics and Astronomy) as the two Academicians at LSU and the first elected while at LSU since 1959. This is a very high recognition and we are very proud of Professor Gonzalez.

LIGO Continued from page 1

state of the instruments to make sure that the signal isn't caused by a glitch in the detector," said Marissa Walker, who recently received her Ph.D. from LSU. She will continue to work with LIGO as a postdoctoral researcher in the California State University-Fullerton's gravitational waves group.

LIGO made the first-ever direct observation of gravitational waves in September 2015 during its first observing run since undergoing major upgrades in a program called Advanced LIGO. The second detection was made in December 2015. The third detection, called GW170104 made on Jan. 4, 2017, is described in a new paper accepted for publication in the journal Physical Review Letters.

In all three cases, each of the twin detectors of LIGO detected gravitational waves from the tremendously energetic mergers of black hole pairs—collisions that produce more power than is radiated as light by all the stars and galaxies in the universe at any given time. The recent detection appears to be the farthest yet, with the black holes located about 3 billion light-years away. (The black

holes in the first and second detections are located 1.3 and 1.4 billion light-years away, respectively.)

The newest observation also provides clues about the directions in which the black holes are spinning. As pairs of black holes spiral around each other, they also spin on their own axes—like a pair of ice skaters spinning individually while also circling around each other. Sometimes black holes spin in the same overall orbital direction as the pair is moving—what astronomers refer to as aligned spins—and sometimes they spin in the opposite direction of the orbital motion. What's more, black holes can also be tilted away from the orbital plane. Essentially, black holes can spin in any direction. The new LIGO data cannot determine if the recently observed black holes were tilted but they imply that at least one of the black holes may have been non-aligned compared to the overall orbital motion. More observations with LIGO are needed to say anything definitive about the spins of binary black holes, but these early data offer clues about how these pairs may form.

Crawfish Boil

The annual department crawfish boil, held on the Friday of finals week, featured 350 pounds of crawfish, 20 pounds of potatoes and 150 pieces of corn. Almost 100 people socialized outside of Nicholson Hall for the event. To view a photo gallery of the event, visit <http://bit.ly/2rXqgBt>



Awards and Graduates

2016-17 Graduates

Fall 2016 Graduates

B.S.: Emily Kramer, Brandon Sciortino, and Robert Young Phan

M.S.: Erin Chambers, Noah Davis, and Christopher Greenley

Ph.D.: Zhenyu Diao, Yun Ding, Jianping Lai, and Robinjeet Singh

Spring 2017 Graduates

B.S.: Anthony Davila, Daniel DiMarco, Brandon Lockett, W. Craig Jones, Sean Laughlin, Lucas Lavoie, Simon Lorenzo, Dylan Ottea, Patrick Quebedeaux, and Irene Vargas-Salazar

M.S.: Kyle Joerres

Ph.D.: Kundan Kadam, Jiayum Pan, Mohammad Saghayezhian, and Marissa Walker

Summer 2017 Graduates

B.S.: Tyler Herrmann, Amy LeBleu, Brian Razin, and Logan Woolsey

M.S.: Sergio Caceres, Elisha Siddiqui, and Phillip Wall

Ph.D.: Seth Camp, Enzhi Li, Conrad Moore, Gaomin Wang, and Zhichao Xue

College of Science and Department Awards

Derek Walker	Outstanding College Junior Award
Simon Lorenzo	Keen-Morris Award
Irene Vargas-Salazar	Keen-Morris Award
Margarite Laborde	Willie Belle Shockley Scholarship
Chris Abadie	Annie and Willie Austin Scholarship
Rory Bentley	Frank J. and Phyllis Heroy Scholarship
Zach Bradshaw	Tiger Athletic Foundation Scholarship
Megan Chesal	Tiger Athletic Foundation Scholarship
Jonah Hoffman	Tiger Athletic Foundation Scholarship
Dalgis Mesa	Tiger Athletic Foundation Undergraduate Teaching Award

Department of Physics & Astronomy Awards

Undergraduate Research Award
Ivan Hidrovo, Jonah Hoffmann, & Sean Laughlin

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

Outstanding Graduate Student Teaching Award
Chris Greenley, Tyler Ellis, & Zhihao Xiao

Undergraduate Learning Assistant Award
Derek Walker

Undergraduate Faculty Teaching Award
Ivan Agullo

Graduate Faculty Teaching Award
Jonathan Dowling



Derek Walker, Irene Vargas-Salazar, Simon Lorenzo, and Department Chair John DiTusa

Physics Block Party

ANNUAL KICK-OFF WELCOME EVENT FOR STUDENTS AND FACULTY

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

The graduate students vs. professors IQ challenge proved to be an intense contest of intellect between the contestants. First place was awarded to Prof. Ravi Rau. Sample questions included:

Who is the author of the book titled "Schroedinger's Killer App"?

Answer: LSU Professor Jonathan Dowling



Grad Students participate in the minimum-acceleration duels at the 2015 Block Party.

Numerically, what is the inverse of the atomic fine structure constant to three significant digits?

Answer: 137 for 137.035999173 or just 137.036

For a list of additional questions/answers, competition results and winners, visit: www.phys.lsu.edu and click on graduate programs.



Students challenge each other in a game of chess

Distinguished Speakers Visit LSU

HEARNE EMINENT LECTURE

DECIPHERING the BEGINNINGS of the UNIVERSE *Matias Zaldarriaga, Institute for Advanced Study*

Over the past twenty years a series of ever more sensitive astronomical observations have provided us with many facts and various clues about the first moments in the history of our Universe. In his talk, Dr. Matias Zaldarriaga summarized our current understanding, some of the open questions and how we might go about tackling them.



Matias Zaldarriaga (center) with LSU Physics & Astronomy students and faculty

Zaldarriaga has made many influential and creative contributions to our understanding of the early universe, particle astrophysics, and cosmology as a probe of fundamental physics. Much of his work centers on understanding the clues about the earliest moments of our universe encoded in the Cosmic Microwave Background, the faint glow of radiation generated by the Big Bang, and in the distribution of matter in the late universe.

QUANTUM SHANNON THEORY - on the ULTIMATE PHYSICAL LIMITS of COMMUNICATION *Andreas Winter, Universidad Autònoma de Barcelona*

What are the ultimate limits of storing and communicating information? Since we believe that fundamentally everything is quantum, quantum mechanics gives some nontrivial answers to this question. Also, our existing communication technology is pushing us ever closer to the quantum realm. In fact, recent years have seen an explosion of ideas and results in the study of communication problems in a fully quantum mechanical setting.



Andreas Winter (center) with LSU Physics & Astronomy students and faculty

MAX GOODRICH DISTINGUISHED LECTURE

The EXPLORATION of PLUTO by NASA's New HORIZONS

S. Alan Stern, NASA New Horizons Mission / Southwest Research Institute

New Horizons is NASA's historic mission to explore the Pluto system and the Kuiper Belt. The fastest spacecraft ever launched, New Horizons left Earth on 19 January 2006. It made the first exploration of the Pluto system—3 billion miles from Earth—last summer, culminating with a highly successful flyby inside the orbits of all five of Pluto's moons on July 14th. Dr. Stern described the history of the mission, the encounter with planet Pluto, the major scientific discoveries made to date, and the public reaction to the flyby.



(l-to-r) Geoff Clayton, S. Alan Stern, and graduate students Kundan Kudam, Kelsie Krafton, & Zhichao Xue

One of the most exciting developments is that the bit, the familiar and ubiquitous information unit in Claude Shannon's eponymous theory of information, now comes with exotic 'cousins' in the form of other elementary resources: the quantum bit (qubit), the entanglement unit (ebit), etc, besides what we now call the classical bit (cbit). Quantum Shannon theory thus not only aims to put a number to the ultimate communication capacity - or rather: capacities - of optical fibers and the like, but really becomes a theory of these fundamental resources and their interplay. From what we can glimpse of it, it has a rich, exciting and sometimes bewildering structure: from quantum teleportation, to unconditionally secure communication based on quantum principles, to paradoxical effects such as superactivation where two communication links, each of which cannot transmit quantum information, together can achieve this perfectly.



LSU Society of Physics Students

by Margarite Laborde, LSU SPS President

During the 2016-2017 school year, our chapter took steps towards becoming more social with other SPS chapters in the area. We took a trip with the Louisiana Tech SPS club on March 17 to play laser tag and then visited LIGO on March 18. This was a great opportunity to make connections with other physics students as we blew off some end-of-the-semester steam, while also discussing interesting topics, such as the research different students were involved with at their respective universities.

Our chapter also interacted with the University of South Alabama SPS club with a pizza lunch and tour of LSU physics labs. They were on their Spring Break trip and asked to come visit, so we were able to meet them, as well as show off some of the cool research being done at LSU.

During the first week of school, multiple SPS officers including Simón Lorenzo (president), Margaret Carey (Secretary), Rory Bentley (public relations), and Dylan Ottea (Web Master) visited the freshmen physics introductory lecture to invite them to our first SPS chapter meeting as well as welcome them to hang out in the Physics Students Library upstairs in Nicholson Hall.

Another important recruitment activity we began in the 2015-16 school year and continued this year was the Physics mentor/mentee program. Margarite Laborde, SPS Vice-President 2016-17, assigned an upperclassman physics student to each underclassman student seeking a mentor based on similar interests. The pairs are then encouraged to hang out, and the mentor is available to offer the mentee scheduling advice and answer any questions pertaining to being a physics major.

The first event SPS was involved in this semester was the annual Physics Block Party, which is hosted by the Physics Department every year.

We contributed by making the liquid nitrogen ice cream for the party (with chocolate toppings and sprinkles of course!). During our off shifts, however, we join in the ping pong and chess tournament fun!

An annual favorite is our Department-wide Nerf War, which was held this year on September 15 in Nicholson Hall. All participants were divided into two teams, and battled the night away while Margarite Laborde, Vice-President for the 2016-2017 school year, and Rebecca Ditusa, Event Coordinator for the 2016-2017 school year, refereed.

On October 22, some of our club members volunteered to make liquid nitrogen ice cream for the Physics Department's Alumni Tailgate held on campus before the LSU v. Ole Miss Football Game. Events like these are great ways to keep alumni connected to not only LSU's Physics Department, but also our SPS club.

At the end of October, SPS hosted a Physics Halloween Party on October 28. At this party, we had fun games like mummy rolling contests and pass-the-flashlight scary story telling. It was a hit, and the Halloween candy refreshments were great too!

A couple of weeks later, our club took a camping trip to Clear Springs Campground in Homochitto National Forest in Mississippi. We went on hikes in the woods, set up our tents, roasted some marshmallows, and were lead in star-gazing through SPS Public Relations Officer Rory Bentley's telescope.

Our end-of-the-year SPS social event was the Physics Prom. We held it the same night as the Sigma Pi Sigma Induction. It was a great night of music, dancing, snacks, and socializing as all of the students in the Physics department had a chance to blow off some steam before finals. At the end of the year, LSU invites all freshmen applicants who

scored at least a 28 on the ACT to attend SPIN (Spring Testing Invitational Event). At this event, the freshmen take tests to get credit for classes and schedule their classes for the fall of their freshmen year. The SPS club provided students to help any of the freshmen planning on majoring in physics choose their classes. This is a great way that the Physics & Astronomy Department stands out from other science departments because others only have professors advising, but we bring students. Many SPS members have remarked that the student advising was very helpful to them when they came in as freshmen.



Dylan Ottea and Margarite Laborde demonstrate physics experiments at the LASM Engineering Day in Baton Rouge.



Margarite Laborde and Simon Lorenzo attended the OSA Conference in Rochester, NY.



SPS Secretary and Event Coordinator for the 2016-2017 school year, Margaret Carey and Rebecca DiTusa, helped prepare liquid nitrogen ice cream for the department alumni tailgate.



New Sigma Pi Sigma members Dylan Ottea, Amy LeBleu, Irene Vargas-Salazar, Simon Lorenzo, and Daniel DiMarco.

What I did with my Physics Degree

This year's series of discussions with alumni and students on the general topic of career opportunities featured Dr. Leanne Truehart and Tom Harrington.

Dr. Truehart received her BS in Physics in 1990. She was very active in many groups while at LSU, worked in the Cosmic Ray Astrophysics Group and was elected president of the Society of Physics Students. Dr. Truehart is a board certified adult psychiatrist and received the Exemplary Psychiatrist Award from the National Alliance on Mental Illness in 2014. She serves as the clinical director of the Behavioral Health Court for the 22nd judicial district.

Her fascination with space initially led her to major in physics and pursue a career in astronomy, but later in her academic career she did a rotation in psychiatry and proceeded to medical school.

Harrington received his BS in Physics in 1981 and his MS in Electrical Engineering in 1983. He is Co-Founder & Chief Technology Officer at D3 Semiconductor, LLC, has more than 30 years of semiconductor industry engineering and management experience. In addition, he is an entrepreneur with 14 US patents and several international patents awarded. Most recently, he served as managing director of Technology Development for Maxim Integrated Products. Tom leverages his mixed signal experience from Maxim and Dallas Semiconductor to drive innovation into D3's power technology.

Harrington talked about how his LSU physics degree was/is the underpinning for his career path. "I'm convinced that no matter which technical field a person is ultimately interested in, the physics curriculum provides the best grounding and launch pad for all the other fields."



For more information, visit <http://bit.ly/2tIPGIZ> or to participate in the series, please contact Mimi LaValle at mlavalle@lsu.edu

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 mlavalle@lsu.edu

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, Mars, Venus, and Moon-on-a-half-

shell

- Venus, Jupiter, and the Quarter Moon
- Mars, Venus, First Quarter Moon
- Venus and Mars conjunction
- Half Moon and Orion Nebula
- Aldebaran disappears (Uranus near Mars)
- Mercury at greatest elongation

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

Gonzalez and Newhauser Present at TEDxLSU

The 2017 TEDxLSU event featured two professors from the department, Gabriela González and Wayne Newhauser.

Gaby González and her team at LIGO have proven that when you search for the small numbers you can make massive discoveries - like proving Einstein's theory of gravitational waves, which are smaller than even the smallest piece of an atom. In this talk, Gaby takes us through the process of g-wave discovery and introduces us to another small number we should be looking at if we want to continue scientific innovation: the small number of women working in physics. **View her talk at <http://bit.ly/2vmta0r>**

What if the key to optimizing breast cancer treatment can be found via channels outside the medical profession? In this talk, medical physicist Wayne Newhauser discusses how he turned to unlikely collaborators in his quest to increase the effectiveness of certain types of breast cancer treatment: artists and makers using 3D technologies. **Watch his talk at <http://bit.ly/2tc5YoO>**



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

Saturday Science

Among the topics covered at the monthly Saturday Science events:

“Discovering the newest species in the human lineage: *Homo naledi*!” *Juliet Brophy, Department of Geology and Anthropology*

“We are all Stardust” *Catherine Deibel, Department of Physics & Astronomy*

“The Mississippi River Delta: How it Formed, Why it is Disappearing, & Why We Should Preserve it?” *Sam Bentley, Department of Geology & Geophysics*

“The Science of the Deepwater Horizon Oil Spill” *Emily Maung-Douglass, Louisiana Sea Grant College*

“Is Zika Such a Big Deal Now Because it has Changed?” *Rebecca Christofferson, School of Veterinary Medicine*

“Unraveling Evolutionary Tales Hidden in Genomes” *Jeremy Brown, Department of Biological Sciences*

“Camers (Gamma Detector) for the Heart” *Joyoni Dey, Department of Physics & Astronomy*

The Physics of Superheroes” *James Kakalios, Taylor Distinguished Professor in the University of Minnesota’s School of Physics & Astronomy*

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.



Nanoscale structures, such as a single strand of DNA or gold nanoparticles in church windows, have existed in nature and been used long before scientists began devoting their studies to them. Recently, this innovative field of study has contributed to numerous discoveries such as 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.

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 and students operate the telescope on public nights. Public lectures from LSU Physics & Astronomy faculty, postdocs, and students covered a diverse array of topics including: “Voyager - Legendary NASA Mission” (Rory Bentley), “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), “Stellar Evolution” (Juhan Frank), “Quantum Physics” (Daniel Sheehy), “Life on Exoplanets” (Tyler Ellis), Einstein, Gravitational Waves and Black Holes” (Gabriela Gonzalez) 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.

The Observatory is run through a partnership between BREC, LSU Physics & Astronomy and the Baton Rouge Astronomical Society. Over the years LSU has continued to invest in the HRPO technology including a second large telescope, a radio telescope, a radio station, a bank of workstations, multiple portable telescopes, a portable planetarium, a digital portable planetarium, a high speed network, two major upgrades of the telescope control systems and various audio / visual equipment.

NanoDays and LASM Engineering Day

For the **eighth** 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, including:

- How a Scanning Probe Microscope helps scientists explore the nanoworld
- Nanomaterials used to make stain-free clothes
- Playing with liquid crystals and magnets
- Making an Oobleck, a liquid with both liquid and solid properties
- Professor Dan Sheehy presented “Living in the Age of Quantum Physics”

Juana Moreno, associate professor of both the Center for Computation & Technology and the Department of Physics & Astronomy and 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 displayed a radiation survey meter to detect household items that 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.

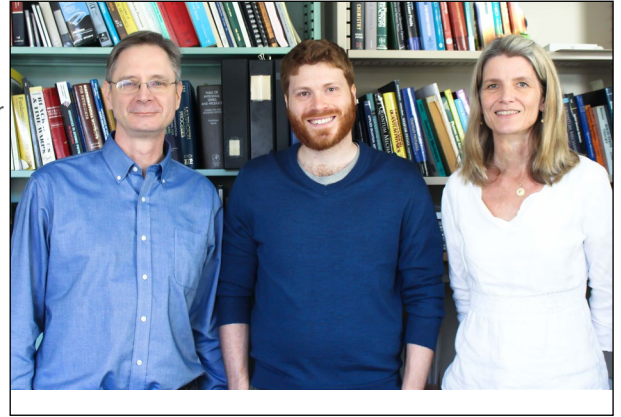


Controlling Fast X-ray Pulses with Laser Light

When hit by light, electrons are excited and begin to move. Ultrafast x-ray pulses may make it possible to watch the motion of these electrons as they move inside and between atoms in a material. Although scientists have gotten much better at making ultrafast x-rays in recent years, controlling them is still notoriously difficult. Researchers at LSU and Lund University in Sweden have demonstrated a new method to direct short bursts of x-ray light that uses strong laser pulses.

“This work is really the culmination of years of studies by the strong field laser physics team -- how to use lasers to both make and control x-rays,” said Professor Kenneth Schafer, who leads the research team in the LSU Department of Physics & Astronomy.

The new method, reported today in the journal *Nature Photonics*, works by using pulses of infrared laser light to transform the way that matter interacts with x-rays. In this work, the researchers at Lund University and LSU have used laser pulses to change a gas of atoms so that rather than absorbing the x-ray light along one direction, the atoms are instead stimulated to emit x-ray light along a completely different direction, and at a time that the scientists can control.



(l-to-r): Kenneth Schafer, Seth Camp (Post-doc), and Mette Gaarde

Physicists Discover Hidden Aspects of Electrodynamics



Radio waves, microwaves and even light itself are all made of electric and magnetic fields. The classical theory of electromagnetism was completed in the 1860s by James Clerk Maxwell. At the time, Maxwell’s theory was revolutionary, and provided a unified framework to understand electricity, magnetism and optics. Now, new research

led by Assistant Professor Ivan Agullo, with colleagues from the Universidad de Valencia, Spain, advances knowledge of this theory. Their recent discoveries have been published in *Physical Review Letters*.

Maxwell’s theory displays a remarkable feature: it remains unaltered under the interchange of the electric and magnetic fields, when charges and currents are not present. This symmetry is called the electric-magnetic duality.

However, while electric charges exist, magnetic charges have never been observed in nature. If magnetic charges do not exist, the

symmetry also cannot exist. This mystery has motivated physicists to search for magnetic charges, or magnetic monopoles. However, no one has been successful. Agullo and his colleagues may have discovered why.

“Gravity spoils the symmetry regardless of whether magnetic monopoles exist or not. This is shocking. The bottom line is that the symmetry cannot exist in our universe at the fundamental level, because gravity is everywhere,” Agullo said.

Gravity, together with quantum effects, disrupts the electric-magnetic duality or symmetry of the electromagnetic field.

Agullo and his colleagues discovered this by looking at previous theories that illustrate this phenomenon among other types of particles in the universe, called fermions, and applied it to photons in electromagnetic fields.

“We have been able to write the theory of the electromagnetic field in a way that very much resembles the theory of fermions, and prove this absence of symmetry by using powerful techniques that were developed for fermions,” he said.

This new discovery challenges assumptions that could impact other research including the study of the birth of the universe.

Read for further information <http://bit.ly/2uOmZ5M>

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

LSU Physicists Collaborate on T2K CP Violation Results to Explain Workings of Universe

Why the universe is dominated by matter today, instead of being comprised of equal parts matter and antimatter, is one of the most intriguing questions in all. One of the conditions required for the observed dominance of matter over antimatter to develop is the violation of the Charge-Parity (CP) symmetry, which is the principle that the laws of physics should be the same if viewed upside-down in a mirror, with all matter exchanged with antimatter. If CP violation occurs in neutrinos, it will manifest itself as a difference in the oscillation probabilities of neutrinos and antineutrinos.

LSU physicists Thomas Kutter and Martin Tzanov were among the international T2K Collaboration who recently announced their findings on the symmetry between

neutrino and antineutrino oscillations. With newly collected antineutrino data, T2K has performed a new analysis, fitting both neutrino and antineutrino modes simultaneously. T2K's new data continue the trends observed in 2015, which is a preference for maximal disappearance of muon neutrinos, as well as a discrepancy between the electron neutrino and electron antineutrino appearance rates.

In the T2K experiment in Japan, a muon neutrino beam is produced at the Japan Proton Accelerator Research Complex (J-PARC) located in Tokai village, Ibaraki Prefecture, on the east coast of Japan. The neutrino beam is created by directing protons from the J-PARC accelerator onto a target to produce an intense secondary particle beam that is focused and filtered by

strong magnetic fields. The focused particle beam decays into a beam of muon neutrinos or antineutrinos, depending on the field direction. The neutrino/antineutrino beam is monitored by a detector complex, 280 m away from the neutrino target, and aimed at the gigantic Super-Kamiokande underground detector in Kamioka, near the west coast of Japan, 185 miles away from Tokai.

Kutter and his LSU research team of post-docs and students have designed and constructed part of the T2K near detector, which maps out the neutrino beam on its way to the Super-Kamiokande far detector. Physicists at LSU continue to operate the experiment, to collect data and make significant contributions to the analysis.

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

Dey & Stadler develop their inventions with funds from LSU's LIFT2 grant program

Technology that will improve X-rays and medical imaging is one of the innovations the LSU Board of Supervisors recently selected to support through its innovation and technology transfer grant. Assistant Professor Joyoni Dey, along with a Ph.D. student and colleagues at the LSU Center for Advanced Microstructures and Devices, are investigating the technology to create more detailed X-rays that will aid doctors analyzing lung and bone joint scans. This technology will also provide higher contrast images for mammograms.

"We are proud to support the research



Assistant Professor Joyoni Dey

conducted by our world-class faculty at LSU as they work to advance technologies that will improve health and build economic prosperity," said Scott Ballard, chairman of the LSU Board of Supervisors.

If Professor Shane Stadler's invention hits the market, the systems that cool our homes, cars and freezers could change drastically.

The current system for cooling uses compressed gas technology and emits fluorocarbon gases, which can be harmful and are "cumbersome," says Stadler. With technology that uses a magnetic field to heat and cool, Stadler's invention eliminates the use of harmful fluorocarbons and reduces energy usage by 20% to 50% in cooling systems.

"A lot of testing still has to happen, but one could see something happening in five years if the material and engineering works



Professor Shane Stadler

out," Stadler says. "There's a lot of things to explore and a lot of potential."

His research began with a grant from the U.S. Department of Energy, but he needed more money for additional testing to make the invention "attractive" to an investor. That's where the LIFT2 grant came in. "The LIFT funding was absolutely crucial to get to that point," he says.

Local entrepreneur Herbert Presley created a company, Magnetic Cool, for the purpose of licensing and commercializing Stadler's invention.

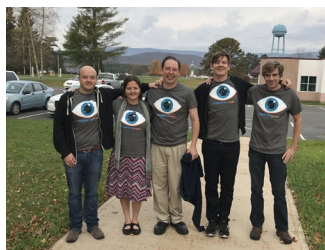
Excerpted from the Baton Rouge Business Report. <http://bit.ly/2dGWytj>

KIC 8462852 The Most Mysterious Star in the Universe

Tabetha Boyajian, an assistant professor of Physics and Astronomy at LSU as of fall 2016, has a star in her name. But Tabby's Star, or more officially KIC 8462852, is not just any old star. It's been called the most mysterious star in the universe.

By monitoring the light curves of KIC 8462852, Planet Hunters volunteers found that the star regularly undergoes a series of odd, sharp dips in brightness. But these dips are so strange, so irregular, that they cannot be explained by a planet transiting the star or any other behavior that stars are known to have. "The human brain has an amazing ability for pattern recognition, sometimes even better than a computer," Boyajian said during a TED talk in 2016.

Boyajian joined the Planet Hunters team in 2012 as a postdoctoral fellow in the exoplanets group at Yale. Soon afterwards she was notified by Planet Hunters users of a very unusual star. "When Planet Hunters users were classifying the Kepler data, they came across this one star that did not fit into any category that they had seen before," Boyajian says.



Drs. Andrew Siemion, Tabby Boyajian, Jason Wright, Danny Price, Dave Macmahon after a night at Green Bank Observatory.

Boyajian published a paper about KIC 8462852 in 2016, and as a researcher at LSU continues to study this particular star, amongst other stars, in collaboration with various citizen groups and amateur observers. Boyajian concluded that the most likely explanation for the light dips in data from the star was the passage of a family of exocomets or planetesimal fragments, or debris left over from comet collisions. One of the strangest and most unlikely explanations that others have suggested is that an alien megastructure surrounds the star.

Since the original discovery of the star, Boyajian has been working with amateur observers and astronomers through the American Association of Variable Star Observers (AAVSO) to get more data from individual observations of KIC 8462852, which can be clearly seen using a small telescope. Following an AAVSO alert about this star in October 2015, more than 50 observers around the world have been contributing data to the AAVSO database that Boyajian can use. The observers come from all walks of life, from a former engineer at NASA JPL to an owner of a bike shop in Arizona.

Only time will tell Boyajian what exactly is passing in front of the most mysterious star in the universe.

Exotic Nature of High-Field Superconductivity

Professor Phil Adams is a leading expert in how superconductors respond to high magnetic fields. In general, superconductors and magnets do not get along. A strong enough magnetic field destroys superconductivity by disrupting the precisely coordinated motion of electrons that allows current to flow without resistance. Recently, Prof. Adams' group and collaborators at the University of Texas, Austin have been studying the behavior of superconducting films that are only a few atomic layers thick. In particular, they have used a magnetic field to "tug" on the spins of the superconducting electrons in order to see how the superconductor responds.

In a classic superconductor, electric current is carried by so-called Cooper pairs of electrons. The electrons only pair at low temperatures but they do so in a very specific manner. For example, if at any moment in time, one electron has its spin pointed up, and it is moving left, then its Cooper pair partner will have its spin pointed down, as it moves to the right. These Cooper pairs do not easily scatter off of impurities and/or defects in the film and thus give rise to zero-resistance current flow, which is the hallmark of superconductivity. By appropriately applying a magnetic field to the superconducting films, Prof. Adams' group can exert a twisting force on the electron spins that attempts to rip the Cooper pairs apart. The primary focus of their research is to understand

how the superconductor responds to this pull on its spins. In a paper published earlier this year Prof. Adams and collaborators were able to show that the superconducting state takes on unexpected properties when subjected to an extreme spin torque

[1]. Indeed, they speculate that a new form of superconductivity emerges when the applied magnetic field is on the verge of destroying the Cooper pairs. Instead having oppositely aligned spins, the emergent phase finds a way to produce Cooper pairs with parallel spins, as the system tries to accommodate the applied field. Prof. Adams' research is supported by the Department of Energy's Office of Basic Energy Sciences.



[1] Zeeman-limited Superconductivity in Crystalline Aluminum Films, P.W. Adams, H. Nam, C.K. Shih, and G. Catelani, Phys. Rev. B 95, 094520 (2017).

Medical Physicist Rui Zhang Works to Improve Treatment Outcomes for Postmastectomy Patients

About one in eight U.S. women will develop invasive breast cancer over the course of her lifetime. An estimated 231,840 new cases of invasive breast cancer are expected to be diagnosed in women in the U.S. and about 40,290 women are expected to die from breast cancer this year. Assistant Professor of Physics Rui Zhang was awarded a grant from the National Cancer Institute, NCI, to improve treatment outcomes for breast cancer patients.

A mastectomy is highly recommended for patients with locally advanced primary breast cancer and extensive lymph node involvement. Due to the prevalence of microscopic diseases after the mastectomy, postmastectomy radiotherapy, or PMRT, is commonly performed on these patients to sterilize the residual tumor cells, and has been shown to improve the overall survival rate among patients with invasive breast cancer by reducing the risk of tumor

recurrence and cancer mortality. However, long term survivors may develop life threatening acute and chronic treatment-related toxicities after radiotherapy. For example, the risk of ischemic heart disease increases with breast cancer radiotherapy dosages, according to previous studies.

PMRT options include external beam photon therapy, electron therapy and proton therapy, each with various degrees of sophistication and cost. Most of these technologies will provide comparable target coverage, while the dose to surrounding normal tissues varies greatly. The more advanced techniques, like intensity modulated radiotherapy and proton therapy, have the potential to improve long term survival by constraining doses to radiosensitive organs, but evidence from an outcome study will not be available until years or decades later. Furthermore, the literature is largely incomplete regarding systematic comparison of potential benefits of advanced technologies for PMRT. Clinical and policy decision making is difficult because of the many possible treatment strategies, the rapid technological advancement of radiotherapy and an insufficient evidence base.

Zhang's research evaluates the efficacy of various PMRT techniques and offers rigorous theoretical evidence that will help guide clinical decision making, especially modality selection for PMRT. The NCI awarded him a \$600,000 grant to support this work.

"With this grant, we will improve understanding of the benefits, weaknesses and effectiveness of various radiotherapy modalities, especially advanced-technology modalities, in the treatment of postmastectomy breast cancer patients. It will facilitate offering evidence-based, effective patient care and can potentially benefit millions of breast cancer patients in the United States," Zhang says.



Assistant Professor Rui Zhang celebrates the NCI grant award with Department Chair John DiTusa

Pullin and Wilde Publish Books on Quantum Topics

Jorge Pullin co-edited a book "Loop quantum gravity: the first 30 years" with Abhay Ashtekar, the Eberly Chair of Physics at the Pennsylvania State University. It includes eight chapters by young emerging leaders of the field providing a snapshot of its state of the art, including one by LSU's Ivan Agullo and Parampreet Singh. The book is part of the series that World Scientific Publishing Co. of Singapore is putting out to celebrate the 100 years of Einstein's General Theory of Relativity. According to the publisher, it will include "two dozen excellent monographs written by top-notch authors from the international gravitational community.

Mark Wilde's Second Edition of his book "Quantum Information Theory" has been published." Developing many of the major, exciting, pre- and post-millennium developments from the ground up, this book

is an ideal entry point for graduate students into quantum information theory. Significant attention is given to quantum mechanics for quantum information theory, and careful studies of the important protocols of teleportation, superdense coding, and entanglement distribution are presented. In this new edition, readers can expect to find over 100 pages of new material, including detailed discussions of Bell's theorem, the CHSH game, Tsirelson's theorem, the axiomatic approach to quantum channels, the definition of the diamond norm and its interpretation, and a proof of the Choi-Kraus theorem. Discussion of the importance of the quantum dynamic capacity formula has been completely revised, and many new exercises and references have been added. This new edition will be welcomed by the upcoming generation of quantum information theorists and the already established community of classical information theorists.

New Assistant Professors



Tabetha Boyajian

Assistant Professor of Physics and Astronomy
Ph.D., 2009 - Georgia State University

Research Interests

Astronomy & Astrophysics

Fundamental properties of stars: diameters, temperatures, exoplanet detection and characterization, Optical/IR interferometry, stellar spectroscopy (radial velocities, abundances, activity), absolute spectrophotometry, binary stars, astrometry, stellar ages and evolution, stellar activity and rotation, asteroseismology.

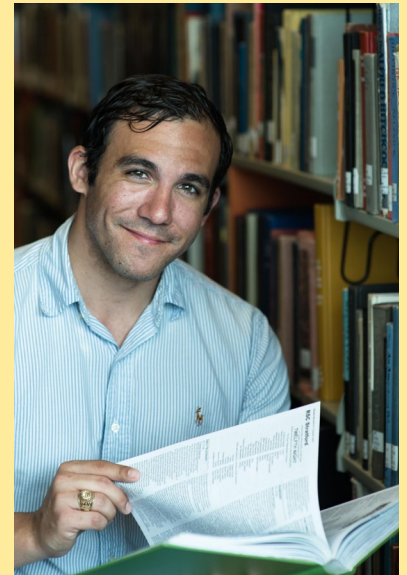
Manos Chatzopoulos

Assistant Professor of Physics & Astronomy
Ph.D., 2013 - University of Texas at Austin

Research Interests

Astronomy & Astrophysics

Theoretical and computational astrophysics, massive stellar evolution, supernovae, peculiar transient phenomena, superluminous supernovae.



Kristina Launey

Assistant Professor
Ph.D., 2003 - Louisiana State University

Research Interests

Theoretical Nuclear Physics and Astrophysics

Strong interaction physics, fundamentals of nuclear physics, applications to nuclei-driven processes in nature.

Selected Publications

“Decays of the Three Top Contributors to the Reactor $\bar{\nu}$ e High-Energy Spectrum, ^{92}Rb , ^{96}gsY , and ^{142}Cs , Studied with Total Absorption Spectroscopy”, B.C. Rasco, M. Wolińska-Cichočka, A. Fijałkowska, K.P. Rykaczewski, M. Karny, R.K. Grzywacz, K.C. Goetz, C.J. Gross, D.W. Stracener, E.F. Zganjar, J.C. Batchelder, J.C. Blackmon, N.T. Brewer, S. Go, B. Heffron, T. King, J.T. Matta, K. Miernik, C.D. Nesaraja, S.V. Paulauskas, M.M. Rajabali, E.H. Wang, J.A. Winger, Y. Xiao, and C.J. Zachary; *Phys. Rev. Lett.* 117, 092501 (2016). <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.117.092501>

“CALET Upper Limits on X-Ray and Gamma-Ray Counterparts of GW 151226” has been published by the CALET collaboration including Nick Cannady, Mike Cherry, Greg Guzik, Amir Javaid, John Wefel et al., *Astrophysical Journal Letters*, 829:L20 (2016). <https://arxiv.org/abs/1607.00233>

“Interrogating the Superconductor $\text{Ca}_{10}(\text{Pt}_4\text{As}_8)(\text{Fe}_2-x\text{PtxAs}_2)_5$ Layer-by-layer”, Kim, Jin, Zhang, & Plummer et al., *Scientific Reports* 6, Article number: 35365 (2016). <https://www.nature.com/articles/srep35365>

“Faint UBVR I Standard Star Fields at $+50^\circ$ Declination”, Clem, J.L., and Landolt, A.U., *Astronomical Journal*, Volume 152 (4), article id. 91, 13 (2016). <http://bit.ly/2dxVoQ6>

“Conformal loop quantum gravity coupled to the Standard Model” by Campiglia, Gambini, and Pullin, *Classical and Quantum Gravity* 34, 02LT01 (2017). <https://arxiv.org/abs/1609.04028>

“Electron interaction with the spin angular momentum of the electromagnetic field”, R F O’Connell, *J. Phys. A: Math. Theor.*, 50 (8), 085306 (2017). <http://iopscience.iop.org/article/10.1088/1751-8121/aa5575/meta>

“Manipulation of entanglement sudden death in an all-optical setup” by A. Singh, S. Pradyumna, A. R. P. Rau, and U. Sinha,

J. Opt. Soc. Am. B 34 (3), 681- 690 (2017). <https://www.osapublishing.org/josab/abstract.cfm?uri=josab-34-3-681>

“Understanding emergent collectivity and clustering in nuclei from a symmetry-based no-core shell-model perspective”, A. C. Dreyfuss, K. D. Launey, T. Dytrych, J. P. Draayer, R. B. Baker, C. M. Deibel, and C. Bahri, *Phys. Rev. C* 95, 044312 (2017). <https://journals.aps.org/prc/abstract/10.1103/PhysRevC.95.044312>

“Numerical simulations of loop quantum Bianchi-I spacetimes”, Peter Diener, Anton Joe, Miguel Megevand and Parampreet Singh, *Class. Quantum Grav.* 34, 094004 (2017). <http://iopscience.iop.org/article/10.1088/1361-6382/aa68b5>

“Observations of V0332+53 during the 2015 Outburst using Fermi/GBM, MAXI, Swift, and INTEGRAL”, Zach Baum, Mike Cherry, and James Rodi, *Monthly Not. Royal Astron. Soc.* 467, 4424 (2017). <http://adsabs.harvard.edu/abs/2017MNRAS.467.4424B>

“Delicate competing electronic states in ultrathin manganite films”, Zhaoliang Liao, Rongying Jin, E. W. Plummer, Jiandi Zhang, *Phys. Rev. B*, 95, 085130 (2017). <https://journals.aps.org/prb/abstract/10.1103/PhysRevB.95.085130>

“Event ontology in quantum mechanics and downward causation” Gambini and Pullin, *International Journal of quantum foundations* 2, 89 (2016) <https://arxiv.org/abs/1605.07531>

“Analytical model for ion stopping power and range in the therapeutic energy interval for beams of hydrogen and heavier ions” Donahue and Newhauser et. al. *Phys. Med. Biol.* 61 (2016) 6570–6584. <http://bit.ly/2zMGPEd>

“Quantum self-gravitating collapsing matter in a quantum geometry” by Campiglia, Gambini, Olmedo, and Pulin,

Classical and Quantum Gravity, Volume 33, Number 18. <http://bit.ly/2BlyV1c>

“Hidden Phases Revealed at the Surface of Double-Layered $\text{Sr}_3(\text{Ru}_{1-x}\text{Mnx})_2\text{O}_7$ ”, *Phys. Rev.* 94, 085420 (2016). Published by Chen, Jin, Zhang, & Plummer et al. <http://bit.ly/2AGy8fi>

“Entanglement dynamics of two nitrogen vacancy centers coupled by a nanomechanical resonator”, Z. Toklikishvili, L. Chotorlishvili, S. K. Mishra, M. Schueler, S. Stagracyński, A. R. P. Rau, and J. Berakdar, *J. Phys. B* 50, 055007 (2017).

“Electromagnetic duality anomaly in curved spacetimes” by I. Agullo, A. del Rio, and J. Navarro-Salas Published in *Physical Review Letters* 118 (2017) no.11, 111301. <https://arxiv.org/abs/1607.08879>

“Cosmological dynamics in spin-foam loop quantum cosmology: challenges and prospects” by David A Craig and Parampreet Singh. *Class. Quantum Grav.* 34 074001 (2017). <http://iopscience.iop.org/article/10.1088/1361-6382/aa601d/meta>

“Energy Calibration of CALET Onboard the International Space Station”, Y. Asaoka, N. Cannady, M.L. Cherry, T.G. Guzik, A. Javaid, J.P. Wefel et al., *Astroparticle Physics* 91, 1 (2017) <http://bit.ly/2Acb5b4>

“Surface Sum Frequency Generation Spectroscopy from non-centrosymmetric Crystal GaAs (001)”, Zhenyu Zhang, Jisun Kim, Rami Khoury, Louis H. Haber, and E. W. Plummer, *Surface Science*, 664, 21 (2017). <http://bit.ly/2naruHW>

“Manipulating the Polar mismatch at $\text{LaNiO}_3/\text{SrTiO}_3$ (111) Interface”, M. Saghayezhian, Zhen Wang, Hangwen Guo, E.W. Plummer, Jiandi Zhang, *Phys. Rev. B* (2017). <https://arxiv.org/abs/1610.08012>

Draayer, González, Kurtz, Matthews, Pullin, and Plummer Distinguished Members and Named Fellows

Jerry Draayer named a fellow by the American Association for the Advancement of Science. <http://bit.ly/2ho3Zr9>

Gabriela González elected as a member to The National Academy of Sciences for her distinguished and continuing achievements in original research. <http://bit.ly/2AdLsmR>

Gabriela Gonzalez elected to the American Academy of Arts and Sciences. <http://bit.ly/2zhP2Q5>

Richard Kurtz named among 2016-2017 SEC Academic Leadership Development Program Fellows. <http://bit.ly/2yajaZT>

Kenneth Matthews named a fellow by the American Association of Physicists in Medicine. <http://bit.ly/2mpWY7M>

Jorge Pullin named fellow of the International Society on General Relativity and Gravitation for his service in the relativity community. <http://bit.ly/2bQj2Xa>

E. Ward Plummer honored with the Award for International Scientific Cooperation from the Chinese Academy of Sciences. <http://bit.ly/2zr0Fnv>

Mette Gaarde Named Outstanding Referee for Physical Review Journals



Professor Mette Gaarde, LSU Department of Physics & Astronomy, has been selected by the American Physical Society (APS) as one of the Outstanding Referees for 2017, who has demonstrated exceptional work in the assessment of manuscripts published in the Physical Review journals.

Instituted in 2008, the highly selective Outstanding Referee program annually recognizes approximately 150 of the currently active referees for their invaluable work.

"This is a well-deserved recognition of Professor Gaarde's outstanding service to the physics community," said John DiTusa, chair and professor, LSU Department of Physics & Astronomy. "Referee work requires wide ranging and detailed knowledge of the field, a deep appreciation of the importance of other's work, and a significant investment of time and effort. Having Dr. Gaarde recognized as an Outstanding Referee reflects the quality of her work and serves as another indication of the stature of the LSU Physics & Astronomy faculty."

Kristina Launey Receives Socolofsky Award

Assistant Professor of Physics & Astronomy Kristina Launey is the recipient of the 2017 Dr. Marion D. "Soc" Socolofsky Award for Teaching Excellence. Launey was presented with the award during a surprise visit to her classroom earlier this month by College of Science Dean Cynthia Peterson and Chair of the LSU Department of Physics & Astronomy John DiTusa.

The Socolofsky Award for Teaching Excellence honors the legacy of the late Marion "Soc" Socolofsky, who was a fierce advocate for students at LSU and one of the College of Science's most influential leaders and educators. Throughout Socolofsky's 36 years at LSU, he served as head of microbiology for 20 years, taught more than 12,000 students, advised more than 250 master's and PhD students and was a member of the Dean's Circle.

The Socolofsky Award recognizes faculty members who embody pedagogic qualities that Dr. Socolofsky was known for, including strong student mentoring and passion for the student experience. Like Socolofsky, Launey has mentored a number of exceptional students including Harvey Shows, physics major and 2016 recipient of the Astronaut Scholarship Foundation Award and a number of other students whose research has been published in top scientific journals.

"I love teaching," said Launey. "In high school, I remember how fascinated I was when in class, I heard for the first time how particle accelerators worked. Now I have the chance to unveil the mysteries of physics to my students."



Chair of the Department of Physics & Astronomy John DiTusa, Assistant Professor of Physics, Kristina Launey, and College of Science Dean, Cynthia Peterson.

Donald Kniffen named to College of Science Hall of Distinction

The LSU College of Science inducted four exceptional individuals into the Hall of Distinction on March 31, 2017, among them Donald Kniffen, 1959 LSU Physics & Astronomy alumnus and NASA research scientist. Kniffen, a magna cum laude graduate, is an accomplished astrophysicist and more than 40-year veteran of the NASA space program. He has been a leader in the national and international high-energy astrophysics community, and is one of the scientists who developed the field of high-energy gamma-ray astronomy. Gamma rays are emitted characteristically by the most energetic and exotic objects in the Universe, and gamma-ray astronomy is now one of the highest priority fields in astronomy.

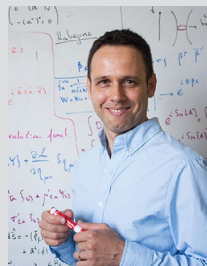
The son of LSU Boyd Professor Fred B. Kniffen, Don was one of the early leaders of gamma-ray astronomy at NASA's Goddard Space Flight Center (GSFC) in Greenbelt, Maryland. From its earliest days, Kniffen launched experiments on high altitude balloons through pioneering satellites, the second Small Astronomy Satellite (SAS-II) and EGRET on board the second "Great Observatory," the Shuttle-launched Compton Gamma Ray Observatory (CGRO). CGRO followed the Hubble Space Telescope. Kniffen served as NASA's Project Scientist for CGRO, for which he was awarded NASA's Medal for Outstanding Leadership in 1992. After retiring from GSFC, he began a second career as a professor and later held a number of top-level science positions within U.S. astrophysics.



Physics & Astronomy Hall of Distinction Honorees, William Hamilton (2016), Donald Kniffen (2017), Arlo Landolt (2014), and Edward Zganjar (2015)

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. 2017 honorees were Jeffrey Hanor, LSU Professor Emeritus in Geology & Geophysics, Neil Kestner, LSU Professor Emeritus in Chemistry, Donald Kniffen, LSU alumnus and NASA research scientist and Sandra McGuire, Director Emerita of LSU's Center for Academic Success and retired chemistry professor. To view a photo gallery, visit: <http://bit.ly/2syAIPa>

LSU Physicist Agullo Awarded Top Gravity Research Prize



LSU Department of Physics and Astronomy Assistant Professor Ivan Agullo has received the first place award from the Gravity Research Foundation for his essay titled "Gravity and Handedness of Photons," which he co-authored with Adrian del Rio and Jose Navarro-Salas, from the Spain's Universidad de Valencia. Adrian del Rio visited LSU for a period of three months in 2016, to work with Agullo on the investigations on which the awarded essay is based.

"This contest has become very prestigious among researchers working in the broad area of gravitation, and very top researchers compete every year," Agullo said. "Winning this competition has become a great international distinction."

The Gravity Research Foundation,

founded in 1949, works to promote scientific research on gravity and annually awards outstanding essays in the field of gravitational studies. Winners of past top essay awards include Nobel Laureates and famous physicists like Stephen Hawking, who won in 1971. The top five essays, including Agullo's, will be published in an issue of the International Journal of Modern Physics. He will also receive a \$4,000 award. Agullo received the foundation's top essay award in 2011 for his work, "Stimulated Creation of Quanta during Inflation and the Observable Universe."

Agullo received his Ph.D. in 2009 at the Universidad de Valencia and has been an assistant professor of physics at LSU since August 2013. He specializes in quantum mechanics, quantum gravity and cosmology. He is the only researcher from LSU who has won this award, and the first of Spanish nationality

Agullo's most recent research focuses on the way gravity and quantum mechanics affect Maxwell's Theory of Electromagnetism. More specifically, his work analyzes how something that was believed to be a fundamental symmetry of this theory, known as electric-magnetic duality, may disappear in the presence of gravity. His 2017 essay builds on this research by analyzing how the handedness, or helicity, of photons behaves under strong gravitational fields.

This discovery may have important consequences for other areas of physics. For instance, this research could be helpful in order to extract information about the evolution of the universe immediately after the Big Bang by analyzing the polarization of the photons that form the cosmic microwave background.

<http://bit.ly/2m6ACgo>

Student News and Updates

Amy LeBleu & Harvey Shows Named 2016 Astronaut Scholars

Retired US Airforce Colonel and NASA astronaut Fred Gregory presented undergraduates Harvey Shows and Amy LeBleu with the Astronaut Scholarship Foundation scholarship. This distinguished honor, created by the six surviving astronauts of Mercury 7, aims to encourage students to pursue scientific endeavors that keep the U.S. on the leading edge of technology.

Harvey Shows began his college career at Southeastern Louisiana University and transferred to LSU after his freshman year, and said it was the faculty and staff in the Department of Physics & Astronomy who encouraged him to excel within his field.

“While the work involved can be strenuous often leading to late nights and early mornings, the prize of finally ‘getting it’ cannot be overvalued,” said Shows.

Last summer, he conducted neutrino physics research at Indiana University.

He has also participated in a quantum computing physics research experience sponsored by the NSF’s Robert Noyce Teacher Scholarship through the LSU GeauxTeach program in Math & Science. He worked as an undergraduate researcher in Assistant Professor Kristina Launey’s research group focusing on nuclear structure theory.

LeBleu has contributed to a number of astrophysics projects, including work in the laboratory of LSU Ball Family Distinguished Professor in Physics & Astronomy Geoffrey Clayton. Her work focused on researching SN2007oc, a type II supernova, and the methods to model the amount of dust produced in the explosion. Her internship was funded by the Sloan Digital Sky Survey. She also helped develop a program to determine if R Corona Borealis (RCB), a peculiar low-mass yellow supergiant star, can be identified only from their spectrum. The program would also be able to scan the Sloan Digital Sky Survey



(l-to-r) Retired US Airforce Colonel and NASA astronaut Fred Gregory, Amy LeBleu, Harvey Shows, and LSU College of Science Dean Cynthia Peterson

catalog to find more RCB stars.

Last summer LeBleu participated in an internship at the Harvard-Smithsonian Center for Astrophysics where her work focused on developing a piece of code for a rare quasar.

“This scholarship is important to me because I want to work with NASA. I think Space exploration is a critical part of the future of mankind, and this scholarship helps inspire me to work harder, and possibly smarter, so I can contribute more. It’s also reassuring to see what I have done as an undergraduate is considered useful. Sometimes in one’s scholastic career it’s hard to see if projects are actually useful, or just resume folder. Something like this shows that what research I’ve done is useful, and only the start of what I hope to be a productive career” said LeBleu.

Kirby Awarded Economic Development Assistantship to Study iMQC MRI to Help Detect Brain Tumors and Fight Obesity

Medical physics graduate student Krystal Kirby, working under Dr. Owen Carmichael at LSU’s Pennington Biomedical Research Center, has been awarded an Economic Development Assistantship by the LSU Graduate School.

The award will provide support for Kirby to study intermolecular multiple quantum coherence (iMQC) MRI. This is an emerging type of MRI that can significantly enhance both tumor contrast and the contrast between brown fat and other tissues. The primary goal of her project is to develop iMQC into a clinically feasible technique that is positioned to help

both radiation oncologists detect brain tumors and obesity researchers assess new obesity treatments.

Quantum coherence imaging hasn’t been used in a clinical setting before, but teaming up with Pennington Biomedical means Kirby’s work to develop the technology could benefit health in a variety of arenas.

In her new role, Kirby will work to develop and characterize a new and unique iMQC MRI pulse sequence, then optimize data collection, reduce image artifacts, and minimize image acquisition time to make the pulse sequence

clinically acceptable.

Most of her time will be spent at Pennington Biomedical, which boasts two 3T MRI machines suitable for her project. Her hope is to collaboratively

develop the technology, secure patents, and license the technology to commercial MRI machine manufacturers, as well as treatment planning systems that utilize MR images for cancer patients.



ALISON DREYFUSS RECEIVES DOE GRADUATE RESEARCH AWARD

The U.S. Department of Energy Office of Science Graduate Student Research, or SCGSR, has awarded doctoral candidate Alison Dreyfuss of Keene, N.H. with funding to conduct part of her Ph.D. thesis research at Lawrence Livermore National Laboratory.

The award will support six months of collaborative research with LLNL physicist Jutta Escher, who is also an LSU alumna.

“Programs like the DOE’s SCGSR awards play an important role in developing the future workforce for the national laboratories, as well as universities,” said Escher.

Dreyfuss will work on a project titled “Understanding nucleosynthesis from a symmetry-informed *ab initio* perspective.”

“The SCGSR award is giving me the opportunity to develop a new theory for nuclear reactions that will help inform us on how the universe produces the matter that is all around us,” said Dreyfuss, who is working on her Ph.D. in nuclear physics with her adviser, LSU Department of Physics & Astronomy Assistant Professor Kristina Launey. “This new method will enable studies that support state-of-the-art experimental investigations of nuclear systems, predict nuclear reaction rates in exotic systems, and improve the nuclear physics needed for astrophysical models, among many other applications.”

“It is exciting to see that nuclear physics remains a vibrant field at LSU,” said Escher. “The recent progress made by LSU’s nuclear theory group, in particular the successful integration of modern

nuclear interactions in the symmetry-adapted *ab initio* approach, is quite promising. I am very much looking forward to working with Ali on new applications of this method and hope this will lead to a longer-term collaboration between LSU and LLNL.”

“Ali is a talented young physicist, and I am

convinced that, in combination with the strong expertise of Escher and access to state-of-the-art computational resources at LLNL, Ali will make important contributions to the mission of the DOE Office of Science,” said Launey.

The award provides support for inbound and outbound travel to the laboratory, and a monthly stipend of up to \$3,000 for general living expenses while at the host DOE laboratory during the award period. The research projects are expected to advance the graduate awardee’s overall doctoral thesis while providing them access to the expertise, resources and capabilities available at DOE laboratories.



Lorenzo and Olivier Receive NSF Graduate Research Fellowships

The National Science Foundation, or NSF has recognized Simón Gabriel Lorenzo, of Baton Rouge, La. and Andrew Paul Olivier, of Houma, La., as 2017 Graduate Research Fellows.

NSF named 2,000 individuals as this year’s recipients of the graduate fellow awards, which provide three years of financial support within a five-year fellowship period – a \$34,000 annual stipend and \$12,000 cost-of-education allowance to the graduate institution. That support is for graduate study that leads to a research-based master’s or doctoral degree in STEM fields, STEM education and social sciences.

Graduating in May from LSU with a bachelor’s degree in physics and a minor in mathematics, Lorenzo is attending Stanford University in the Department of Electrical Engineering/Applied Physics for his doctoral studies in quantum optics and photonics.

“Simón is an extraordinarily bright young student who is already functioning at the graduate level as a senior,” said Dr. Jonathan Dowling, Hearne Chair Professor of Theoretical Physics, LSU Department of Physics & Astronomy. “He picks up new ideas quickly, has exceptional analytical skills, and has developed excellent numerical skills in just the past few semesters. His work promises to contribute intellectually to the global STEM fields, and

he has already demonstrated an interest in positively impacting his community during his studies.”

Lorenzo has been awarded the 2017 Stanford Graduate Research Fellowship, and the 2017 Stanford Enhancing Diversity in Graduate Education Doctoral Fellowship. He was also president of the LSU Chapter of the Society of Physics Students and a member of the Ogden Honors College while at LSU.

Olivier, who graduated in May 2016 from LSU with a bachelor’s degree in physics with a minor in mathematics, worked with LSU Associate Professor Martin Tzanov in experimental high-energy particle physics projects to characterize a new kind of neutrino detector.

“Since he joined my group as a freshman, Andrew was set on becoming a neutrino physicist,” said Associate Professor Dr. Martin Tzanov. “This fellowship is a recognition of his hard work and the quality of the physics program at LSU.”

Olivier currently attends graduate school at the University of Rochester. He was a member of the LSU Chapter of the Society of Physics Students, Ogden Honors College and was a LA-STEM Research Scholar while at LSU.

LSU Alum Soars to New Heights to Explore our Universe

For LSU alum Edward Montiel, flying is pure magic (or actually, science). One airplane in particular, named SOFIA, is serving a bigger purpose for Ed. He has looked out of the windows of this plane to see breath-taking displays of the Northern Lights, and he has used the onboard telescope to visualize stars and planets at levels of detail not possible with any other telescope bound to Earth's surface, using infrared spectrography. This is no ordinary airplane.

Ed looks to the stars as an astronomer and a federal contractor at NASA Ames. He graduated with his PhD from the LSU Department of Physics & Astronomy in August, 2016 and is currently a postdoctoral researcher at University of California, Davis. We asked Ed to tell us more about his life in the stratosphere.

Ed explained, "The plane flies between 40,000 and 45,000 feet above the earth at night, about 10 hours at a time, to perform our observations. EXES is a spectrograph, which means it breaks up light into its individual parts. As opposed to a camera where you are taking a picture of the light and then you look at the spatial distribution of that light, we're actually looking at the individual parts of the light, or its spectra. There are challenges, however, because we are battling air turbulence while trying to do observations".

EdMontiel goes on to explain his favorite part of research "is the payoff when you can get to the point of asking, did we answer our research question or not? Did we answer the question at all, or were we

completely wrong? It is like the end of putting together a puzzle. You put the last piece in and say "Wow"! Or, "What else do we need? Was there a larger puzzle or not?".

Recalling his time at LSU Ed shared that while "it may seem intimidating to have to compete with students graduating from prestigious schools like Harvard, what you might not realize is that at LSU you have the opportunity to work with people that are world experts in their fields. If you take a step back and look, you're actually in a really great position being at LSU. You can pursue your career and end up at NASA or eventually get the job at one of those prestigious schools".

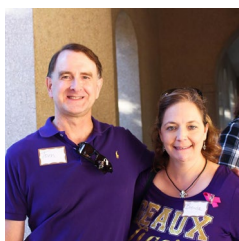
Ed ended with some advice for undergraduate and graduate students, "Don't be afraid to just try. Apply for jobs and see what happens. Put yourself out there and try to get in on projects."



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.

The Department hosted its second alumni tailgate on October 22, 2016. Photos from the event can be viewed at <http://bit.ly/20RT0Vq>



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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.

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



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Stephen Hawking Invites Gabriela González to Speak at his 75th Birthday Symposium



Stephen Hawking & Gabriela González at his 75th birthday public symposium

Professor Gabriela González was one of four high-profile speakers invited to share the stage with Stephen Hawking for his 75th birthday public symposium on Sunday July 2. Her talk was titled 'Black Holes and Gravitational Waves.' Hawking also invited González to present at an international scientific conference entitled 'Gravity and Black Holes' on July 3-4 at the Centre for Mathematical Sciences at Cambridge University.

González is an experimental physicist with the Laser Interferometer Gravitational-wave Observatory, or LIGO, who contributed to the detection of gravitational waves in 2015. These are predicted by Albert Einstein's Theory of General Relativity. Her research and work as the former spokesperson for the 1,000-member international LIGO Scientific Collaboration opened a new window of discovery to the cosmos.