LSU | College of Science
Department of Physics & Astronomy

JULY 2014

SPECIAL POINTS OF INTEREST:

- T2K Observations of $\nu_\mu \rightarrow \nu_e$ Neutrino Oscillations
- Gamma Rays from Lightning
- Race to Build World's First Quantum Computer
- New Approach to Fighting Cancer

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LSU-Department-of-Physics-and-Astronomy

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2014 Conference for Undergraduate Women in Physics

The Department of Physics & Astronomy hosted the South-Central Conference for Undergraduate Women in Physics (CUWiP) January 17-19. The conference was one of eight regional conferences held simultaneously and coordinated through the American Physical Society (APS).

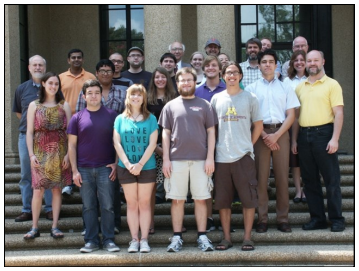
Currently, women constitute less than 20 percent of all physics majors. In many smaller physics programs there are even fewer women in each class. The aim of the CUWiPs is to provide opportunities for undergraduate women physicists to meet, network with, and be inspired by both peers and established women scientists, and to explore the breadth of professional opportunities available to physics majors. The conference showcased different careers in physics through a series of presentations and panel discussions. The 110 participants, 80 of whom were undergraduate students, were engaged in discussions and networking through the weekend. Event activities include poster sessions with peer judges and the opening night career panel, which consisted of five panelists who represented different careers in physics - academia, national lab, industry, medical physics, and education - and who shared both their professional and personal career paths. The conference also featured a number of local and outside distinguished speakers who conveyed their excitement about their particular area of research or expertise. By the end of the conference, many participants reported feeling inspired, empowered, and reinvigorated in their pursuit of a career in physics.

2014 CUWiP participants

The conference was sponsored by both local and federal sources. For a full list of sponsors, see the CUWiP sponsor page at http://www.phys.lsu.edu/cuwip/sponsor.html

Article adapted from article on LSU College of Science website: http://science.lsu.edu

Summer REU Program



Summer 2013 was the fourth summer for the Physics & Astronomy REU program. We had 11 participants this year, selected from 290 applications. In addition to working on research projects, the REU participants toured the CAMD synchrotron and LIGO-Livingston facilities, and participated in weekly seminars by the department faculty. For fun, we went on an Atchafalaya swamp boat tour, spent a day in New Orleans wandering around the French Quarter, and made weekly treks to the LSU Dairy Store. The REU participants ran our annual Astronomy Night program, doing physics demos and making liquid-nitrogen ice cream for students from the other LSU STEM summer programs; Arlo Landolt was the featured speaker for Astronomy Night. We also played in the annual Student-Mentor Softball game with all the LSU STEM summer programs; this year, the Student team pulled out a win, breaking the historical winning streak of the Mentor team. To wrap up the summer, all the students participated in SURF, the annual end-of-summer poster session.

See full list of REU participants on Page 4

Chair's Corner

Michael Cherry, Chair, Department of Physics & Astronomy

We have worked hard over the past six months to update our email contact list of alumni, former colleagues, and friends. To those of you with whom we have managed to reconnect, and to those of you with whom we have remained in contact since you graduated or left, we are happy to send this Spring 2014 edition of our department newsletter.

As you can see inside and on our department website, our students, faculty, and alumni are winning departmental, College, University, and national awards. Our external research funding is at the level of approximately $8.5M annually despite a challenging federal funding climate. We continue to produce noteworthy research in all the areas in which we are involved – and we are working hard to involve our students in that research activity starting in their first year. Approximately 50 undergraduates are on the payroll working with research groups, and another 35 undergraduate students this year worked as Learning Assistants running recitations for our first year Physics courses.

The department's public outreach program continues to be active: The Student Physics Society makes presentations at local schools and had a major presence at the LSU Space Day event that we recently put on together with the College of Engineering, NASA, and Lockheed Martin. The Highland Road Park Observatory operated by the Baton Rouge park district (BREC) and LSU remains popular with the public. Nanodays organized by department faculty has now become an annual event. The Masters in Natural Science program is now in its fourth year of providing science and pedagogy training to local physics and chemistry teachers, the Louisiana Space Consortium (LaSPACE) provides programs and funding for students and faculty across the state, and the Saturday Science lecture series brings high school students and their teachers to campus every month.

We continue to hire new faculty: Ivan Agullo joined us in theoretical relativity and cosmology this year, Guang Jia in medical physics, and Mark Wilde in quantum computing. Joel Tohline and John Wefel retired this Spring, and Joyoni Dey will join us in August in the medical physics program.

We have included news about alumni in this newsletter. Please send us your news and we will gladly include it in the next edition. If you are here in Baton Rouge, let us know and we will be delighted to show you around Nicholson Hall – and if you would be interested in meeting with our undergraduate and graduate students as part of our "What I Did with my Physics Degree" series, please let me know. (We even promise to feed you pizza with the students!)

Congratulations!

Graduates 2013-2014		
B.S.	M.S.	Ph.D
Hanna Broadus	Liudmyla Afanasieva	Christopher Britt
Seth Burleigh	Diane Alvarez	Zachary Byerly
Melanie Carroll	Joseph Bowers	Kuang Chen
Christopher Casey	Christopher Granier	Kalani Hettirachchilage
Christina Davis	John Grenier	Azadeh Keivani
Hannah Gardiner	David McLaughlin	Guorong Li
Dominique Gautreau	Rebecca Ringuette	Qin-Qin Lu
Jacob Granger	Zhang Wanshu	Dalgis Mesa
Ryan Gueho	Adam Watts	Matthew Patterson
Richard Lowe Jr.	Kendrick Williams	Laura Pratt
Corey Myers	Lydia Wilson	Peng Zhang
Gary Patton Jr.		Yuan Zhang
Stephen Pessina		Ziyu Zhang

Winners at 2014 College of Science Choppin Honors Convocation

College of Science Dean's Award: Melanie M. Carroll
College of Science College Honors Award: Melanie M. Carroll
TAF Undergraduate Teaching Award: Dr. Aaron Grocholski
Keen-Morris Award: Hannah Elizabeth Gardiner & Melanie M. Carroll

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Physics & Astronomy Department 2014 Student and Teaching Awards

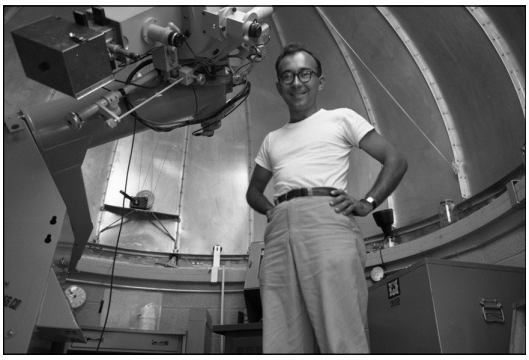
Undergraduate Research Award: Andrew Oliver
Department Service Award: Hannah Gardiner and Collin Hawkins
Outstanding Teaching Assistant: David Heins, William Donahue, and Paul Maggi
Callaway Memorial Award: Christopher Johnson

Landolt Standards and 21st Century Photometry

Landolt

The Department is organizing a conference titled "Landolt Standards and 21st Century Photometry" on campus May 19-21, 2015. Perhaps 10% of modern astrophysics is based on good calibration of star brightnesses, and this all comes back to the world standards developed by Prof. Arlo Landolt. And for the future, highly accurate calibration is still critical. For example, the calibration is currently the biggest uncertainty in measures of the equation of state of Dark Energy as determined with distant Type Ia supernovae, and this has inspired large amounts of effort worldwide at absolute calibration. For future needs, we must get the best calibrations possible for the *Hubble Space Telescope*, and accurate standards for the new Sloan filters (*u, g, r, i, and z)* are needed for the several huge sky survey programs (e. g., PanSTARRS and LSST).

The featured speaker of the conference will be Prof. Landolt himself. It is expected that many of his students and colleagues will be along also. The conference is being organized by Ashley Pagnotta (Ph.D. 2012, SOC), Prof. Geoff Clayton (SOC Chair) and Dr. Aaron Grocholski (LOC chair). The conference location will be announced soon. Plans are for a Star Party to be held at Landolt Astronomical Observatory on the roof of Nicholson. Everyone is invited to this conference.



Landolt

Radiation Safety in Medicine

Dr. Wang , Dr. Day and Dr. Newhauser

A three day professional development school entitled “Radiation Safety In Medicine” was held at LSU in February. More than 90 radiation professionals, mostly from the United States, who are engaged in advanced technology of radiation therapy, diagnostic radiology, and nuclear medicine attended the event. “This continuing education event provides practicing professionals an opportunity to stay abreast of recent developments in radiation medicine”, said Dr. Wayne Newhauser, director of the program and the Mary Bird Perkins Cancer Center (MBPCC)/LSU graduate program in medical and health physics. According to Dr. Wei-Hsung Wang, LSU’s top radiological control official, participation in continuing education has been a key factor in achieving excellent radiation safety practice in medicine, research, and teaching. Dr. Lorraine Day, administrative director of the school and safety officer at LSU’s CAMD, indicated that the school provides opportunities for important cross-pollination of ideas and knowledge across institutions and disciplines, as well as showcasing LSU, MBPCC, and other organizations involved in radiation medicine in Louisiana.

Dr. Stuart Bell, Executive Vice President and Provost, warmly welcomed the participants and faculty, noting LSU’s breadth of activities in radiation sciences. The keynote speaker, Dr. Kenneth Hogstrom, described the evolution of radiation therapy from its beginnings shortly after the discovery of radiation in 1895 to recent research on molecular targeted radiotherapy that promises to revolutionize cancer therapy in the next decade.

Summer REU Program (continued from pg. 1)

Our 2013 REU participants were:

Emily Bell; Monmouth College (mentor: Thomas Kutter), *Muon Decay in Prototype Neutrino Detector*

Samuel Cupp; Austin Peay State University (mentor: Peter Diener), *Evolving the Wave Equation on Hyperboloidal Slices*

Vince Estrada-Carpenter; Southwestern University (mentor: Robert Hynes) *Examining XMM Observations in the Galactic Bulge Survey Region*

Catherine Fielder; Texas Tech University (mentor: Robert Hynes) *The Galactic Bulge Survey: UV Observations*

Morgan Fine-Morris; Bryn Mawr College (mentor: James Matthews) *Determining Cosmic-Ray Composition Trends from Patterns in Air Shower Development*

Daniel Halbe; Western Illinois University (mentor: Gabriela Gonzalez) *Characterization of Motion of Suspended Optics in Advanced LIGO Gravitational Wave Detectors*

Michelle Lollie; Rose-Hulman Institute of Technology (mentor: Jonathan Dowling) *Super-Resolving Single-Photon States from N-Photon NOON States*

Erik Navarro; California State University - Chico (mentor: Jonathan Dowling) *Time-Reversing Photonic Qubit Evolution*

Anthony Risolio; St. John's College (mentor: Kristina Launey) *The Puzzle of Nucleosythesis-Nuclear Structure and Reactions Beyond Stability*

Emily Safron; University of Toledo (mentor: Parampreet Singh) *Cosmological Horizons in Loop Quantum Comology*

Jared Willard; Macalester College (mentor: Mark Jarrell) *Parallel Tempering Monte Carlo Techniques in the Ising Model*

We will have 16 participants in the REU program this summer 2014, starting on May 26, 2014.

http://www.phys.lsu.edu/REU/

http://www.facebook.com/LSUPhysicsREU

Annual Physics Crawfish Boil

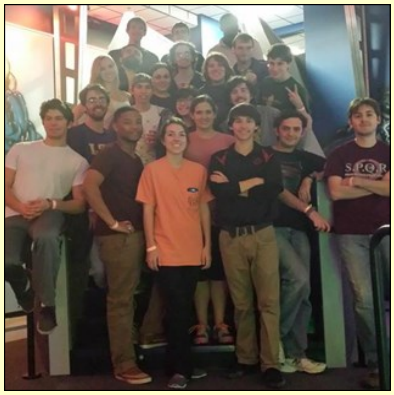
An annual tradition now is the Crawfish Boil on the Friday of Finals Week in May. This is a fun time when everyone in the department stuffs themselves with traditional Louisiana food. Robert Dufrene is the chief organizer, and in 2013 he got 500 pounds of crawfish, 40 pounds of potatoes, and 100 ears of corn. There never seems to be enough potatoes, but there was plenty of the usual drinks and cookies and extras. This last year, 125 people came along, with the tables being set up outside on the porch of Nicholson and overflowing into the Quad. Here are some photos from the 2013 Boil (courtesy of Karen Richard) and the prior year's Boil (courtesy of Ravi Rau).

Visit us on the Web at: phys.lsu.edu

Society of Physics Students

The LSU chapter of the Society of Physics Students started the year doing science demonstrations at the annual Super Science Saturday held at the PMAC on October 19th, 2013. Over 2000 students and parents attended, and we had the opportunity to show off some of the cool gadgets and physics demos that we have. The kids especially loved playing with our Non-Newtonian fluid (a mixture of cornstarch and water) as well as the Van de Graff generator. We also had demonstrations on eddy currents, angular momentum, and radiation. Another exciting opportunity the SPS had this year was to help out with the 2014 Conference for Undergraduate Women in Physics held at LSU in January where our members helped set up the poster session as well as run the liquid nitrogen ice cream social. This year we invited professors in the department to come to speak about their research, what we can do with a physics degree, and any other wisdom that they can pass to us. So far, we have had Dr. Blackmon, Dr. Hynes, Dr. Jim Matthews, Dr. Stadler, and Dr. Dowling speak at our meetings, and we look forward to inviting more professors and alumni to share their experiences with us. Our last event of the semester is a laser tag party for all members who are in good standing. It's a great way to unwind after a long semester as we enjoy a pizza party and several games of laser tag.

One of our SPS members using a Van de Graff generator with Super Science Saturday participants.



Group photo from our end of the semester laser tag party.

If you would like more information about SPS or are willing to come speak to us about your experiences at one of our meetings, feel free to contact our President-elect for the next academic year, Cedric Williams, at cwilla5@tigers.lsu.edu.

Hannah Gardiner, President, SPS

Fulbright Scholar

Newhauser, Wilson, and Provost Stuart Bell

Medical physics student Lydia Wilson was named LSU's most recent Fulbright Scholar. She is currently spending a year in Croatia as part of the Fulbright U. S. Student Program. This program offers fellowships for U. S. graduating college seniors, graduate students, young professionals and artists to study abroad for one academic year.

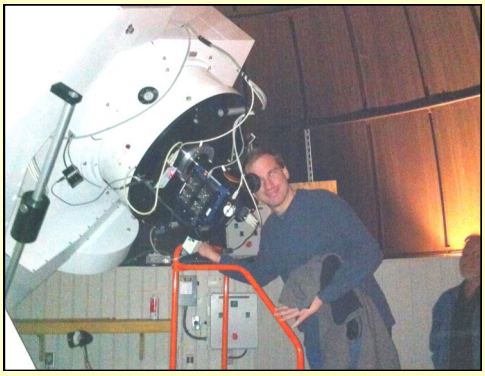
While in Croatia, Wilson is studying disparities in radiotherapy cancer treatment . Wilson is from Chicago but her family roots can be traced back to the Croatian island of Korčula. "Croatia is a perfect place for this type of research. The country is in transition recovering from years of war in the 1990s," says Wilson. "War has major implications on the quality and availability of healthcare treatments, especially for cancer patients. I was curious to see how the country has picked up after being in disarray for so long."

Wilson's work in Croatia includes the opportunity to observe medical physicists and therapists at five radiotherapy centers in Croatia. A majority of her time is spent at the Zagreb Cancer Clinic in the country's capital city. Her research focuses on treatments for the five most common cancers: breast, prostate, lung, colorectal and anal.

Highland Road Park Observatory

The Highland Road Park Observatory has remained a popular public destination on Friday and Saturday nights in Baton Rouge, and celebrated its 15th anniversary last year. You will often find an LSU professor or graduate student operating the telescope on a public night, and public lectures from Physics and Astronomy covered a diverse array of topics including: "The Life and Death of Stars" (Juhan Frank), "LIGO: The Fantastic Search" (Amber Stuver), "The Star of Bethlehem" and "Dating the Crucifixion" (Brad Schaefer), and "Medical Physics" (Wayne Newhauser).

This year we also completed a major upgrade of both our 20" and 16" telescopes. New telescope drives, instrument selectors, and filter-wheels were installed and the mirrors were cleaned. This finally made it possible to replace the ancient Windows 98 computers with 21st Century machines! The new system works wonderfully, ending the pointing difficulties we have sometimes encountered in recent years. This is also the first time that the 16" telescope has had full instrumentation installed, and it can now be operated as a CCD camera, like the 20", from the control room in the main-building. This will be a great asset to our observational courses for physics majors and graduate students as two students will now be able to take project data simultaneously. We are very grateful to Prof. Greg Guzik for spearheading the upgrade project.



Visitors to the Highland Road Park Observatory enjoying views of the sky through the newly upgraded 20" telescope.

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Outreach Activities...

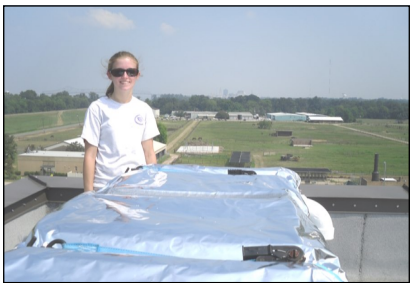
- What I did with my Physics Degree: A series of discussions with alumni on the general topic of career opportunities for department majors: http://www.phys.lsu.edu/newwebsite/news/myphysdegree.html.
- LASIGMA: The Louisiana Alliance for Simulation-Guided Materials Applications (LA-SiGMA) (funded by NSF EPSCoR) provides many research opportunities including REU (undergraduates), RET (school teachers) and REHSS (high school students): http://lasigma.loni.org.
- Saturday Science: The Saturday Science @ LSU series of monthly public lectures by LSU scientists and engineers. Check our department website at http://www.phys.lsu.edu/newwebsite/colloquia/saturdaysci.html for a list of times/dates for Saturday Science.
- Highland Road Observatory: Monthly planet viewing, Friday night lectures and evening viewing on Friday and Saturday nights. Please visit http://www.bro.lsu.edu/ for more information.
- Nano Days: Explore the world of nanoscale science and technology. Nano Days is held each spring. For more information go to http://institute.loni.org/lasigma/events/2014/nanodays_2014.php.
- CAMD: Center for Advanced Microstructures and Devices. Public tours and open houses. For more information go to: http://www.camd.lsu.edu/
- Landolt Observatory: Free public viewing once a month. http://www.phys.lsu.edu/newwebsite/news/observatory.html

Gamma-Rays from Lightning

Terrestrial Gamma-ray Flashes (TGFs) are mysterious millisecond-long bursts of gamma radiation associated with terrestrial lightning. They were surprisingly discovered by the BATSE detectors onboard the Compton Gamma Ray Observatory in 1991, as very short 'gamma-ray bursts' coming from the direction of the Earth. The general idea has to be that the high electrical fields in lightning will accelerate a free electron to high energies, which will knock free more electrons, which will then be accelerated in the electric field, knocking free yet more electrons, and so on, creating an large relativistic runaway electron avalanche. This avalanche of electrons then collides with normal air atoms creating gamma radiation by bremsstrahlung. It is very hard to get observations of TGFs, and to date all data has come from orbiting satellites that fortuitously pass over regions with lightning.

To break this logjam, an LSU group led by Prof. Michael Cherry has been running ground-based and balloon-based observational programs. The ground-based observations are from an array of twelve sodium iodide detectors placed on the roofs of four buildings spread around the LSU campus. These buildings are Nicholson, the Law School, the Vet School, and Taylor Hall. The detectors have run continuously since summer 2010, recording every gamma-ray that hits the detectors, just waiting for a passing thunderstorm. The building of this array plus the collection and analysis of the observations is the Ph.D. thesis project for Rebecca Ringuette. She has reported the first ground-based observations of TGFs, with 24 detections, in a December article in the Journal of Geophysical Research (Ringuette et al. 2013, JGR **118**,7841). These TGFs are seen in multiple detectors within several seconds of nearby lightning flashes detected in radio waves. Critically, they have been able to identify the exact lightning flashes that produced the TGFs and thus recognize the required cloud electrical conditions.

The idea behind the balloon-based program is to use a balloon to carry a gamma-ray detector above a large thundercloud and record the TGFs almost in situ. This will allow good localizations and better spectra, and the individual TGFs can be directly identified with the cloud conditions and lightning that produces them. Ringuette has built the gamma-ray detector and integrated it into a balloon payload, ready for launch from Palestine Texas. A trouble that has arisen is the rather narrow launch window, with a major thunderstorm aimed directly at Palestine, yet with ground winds low enough to allow a successful launch. Despite a lot of ready-and-waiting, the team was not lucky enough to get the right launch conditions last year. The upcoming launch season starts in May.



Rebecca Ringuette

Looking to the future, the LSU team is aiming to build on their success with a large array of TGF detectors in some Caribbean lightning hotspot. The reason to go far south from Baton Rouge is so that their ground observations will occasionally have simultaneous measures from spacecraft (like Fermi or AGILE) passing overhead. The front running candidate site being considered is in western Puerto Rico, where the lightning is especially frequent and LSU already owns a large lot of land.

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Quantum News

Wilde

Prof. Mark Wilde has two new results on Quantum Information theory: First, Wilde and his coauthors have established a revision of the uncertainty principle which quantifies the fundamental trade-off between measurement accuracy error and uncontrollable disturbance that occurs in any measurement of a quantum system. They have used concepts from information theory in establishing this revision. Second, Wilde and his coauthors show that it is possible to violate the no-cloning theorem of quantum mechanics if one has access to a closed timelike curve (a time machine) that behaves according to a model established in 1991 by David Deutsch. Both of these results have appeared in Physical Review Letters. This year Prof. Wilde also received an NSF CAREER award for his proposal "Theoretical and practical aspects of quantum communication".

Exorcizing The Singularity 'Demon' from Black Holes

Pullin

With Einstein's standard General Relativity model for gravity, the center of all black holes will contain a 'singularity', a point where all the matter has been crushed to infinite density. Such an infinity rankles at the hearts of all mathematical physicists, so the idea of a singularity has always been disturbing and daunting. Now, Prof. Jorge Pullin (and Uruguayan colleague Rodolfo Gambini) have demonstrated a way to get rid of the singularity 'demon'. (This has been published recently in PRL, vol. 110 211301 with link http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.110.211301 .) To do this, they have invoked a new model for gravity called 'Loop Quantum Gravity' (LQG). LQG is an attempt to quantize General Relativity. We know that the venerable and experimentally-proven General Relativity must be an incomplete theory because it makes no allowances for quantum mechanics. The combined effects of quantized gravity will only make a noticeable difference when the gravity is extremely high over a small distance scale. Such can only happen in the first tiny fraction of a second after the Big Bang at the start of the Universe, and in this case LQG can lead to no singularity at the origin of time. (See accompanying article on Prof. Singh's work that won him the Vainu Bappu Gold Medal.) Now, Pullin and Gambini have applied LQG to the center of a black hole, where the gravity gets very large over a very small size scale. In LQG, space itself is quantized, and they calculate that a collapsing black hole will not form a singularity of infinite density at its center. This offers a possibility to save mathematical physicists from an infinity, but also offers a way to resolve the notorious problem of whether 'information' is lost to the Universe when it falls into a black hole. Intriguingly, the LQG solution allows for the non-singular core to become connected to some other part of the Universe, or (much more speculatively) to some other Universe (whatever that means). While such 'bridges' are certainly too small for any physical connection or transport (e.g., warp drives) by any conceivable means, they remain evocative to everyone. The LQG solution is just for a simple spinless Schwarzschild black hole, and there will be many refinements coming. The real test of whether this answer is correct will come from tests of LQG in other settings.

Electronic Chirality Observed at the Atomic Scale

A group of researchers in our department (Guorong Li, Biao Hu, Chen Chen, Jing Teng, Zhenyu Diao, Jiandi Zhang, Rongying Jin & E. W. Plummer) working with scientists from Oak Ridge National Laboratory reported in Nature Scientific Reports the first observation of electronic chirality associated with manganese (Mn) doping in strontium ruthenate. Human hands are perhaps the most universally recognized example of chirality: the left hand is a non-superposable mirror image of the right hand. Chemical doping in materials is known to give rise to emergent phenomena. Many useful devices, like the transistor, are based on doping (introducing ions from another species) a mostly "pure" material. This group of researches have shown clear correlations between crystallographic and electronic structure on the atomic scale at the surface of the strontium ruthenate. Although Mn was homogeneously distributed, their results reveal a local electronic inhomogeneity that has two different chiralities. On the surface of the parent compound, there is a tilt distortion, which favors an insulating phase. The introduction of Mn-doping gradually diminishes the surface-induced tilt and thus increases surface metallicity. As the metallicity increases, the effect of electronic inhomogeneity induced by doping diminishes. The lead author, Guorong Li, is a recent PhD graduate of LSU and is now working at Seagate in Minnesota.

Schrödinger's Killer App

Dowling
Eddy Perez/LSU University Relations

Race to Build the World's First Quantum Computer

Prof. Jonathan Dowling has written a book about the exciting possibilities of quantum computers, and how they can (will?) turn our lives upside down. Quantum computers are a big-time competition with high stakes for governments and world finance. (Perhaps the Department should beef up our security to protect the local Quantum Physics group from mysterious foreign *femme fatales* and sinister kidnappers?) The book is written for non-physicists trying to understand what is going on, and I did not see any equations when I read the book. Dowling is working hard to make the weird quantum world understandable to all of us. The book sets itself apart by having many wonderful asides and anecdotes and cutting remarks and deep ponderings that kept me laughing a lot. Here is the description from the back of the book.

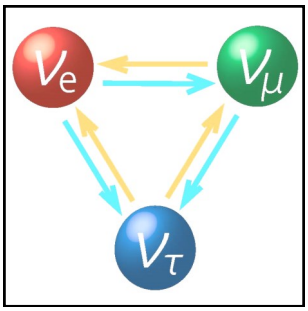
"Written by a renowned quantum physicist closely involved in the U.S. government's development of quantum information science, **Schrödinger's Killer App: Race to Build the World's First Quantum Computer** presents an inside look at the government's quest to build a quantum computer capable of solving complex mathematical problems and hacking the public-key encryption codes used to secure the Internet. The "killer application" refers to Shor's quantum factoring algorithm, which would unveil the encrypted communications of the entire Internet if a quantum computer could be built to run the algorithm. Schrödinger's notion of quantum entanglement—and his infamous cat—is at the heart of it all.

The book develops the concept of entanglement in the historical context of Einstein's 30-year battle with the physics community over the true meaning of quantum theory. It discusses the remedy to the threat posed by the quantum code breaker: quantum cryptography, which is unbreakable even by the quantum computer. The author also covers applications to other important areas, such as quantum physics simulators, synchronized clocks, quantum search engines, quantum sensors, and imaging devices. In addition, he takes readers on a philosophical journey that considers the future ramifications of quantum technologies.

Interspersed with amusing and personal anecdotes, this book presents quantum computing and the closely connected foundations of quantum mechanics in an engaging manner accessible to non-specialists. Requiring no formal training in physics or advanced mathematics, it explains difficult topics, including quantum entanglement, Schrödinger's cat, Bell's inequality, and quantum computational complexity, using simple analogies."

Adapted from article by Taylor & Francis Group located at
http://www.taylorandfrancis.com/books/details/9781439896730/

New Results from T2K Conclusively Show Muon Neutrinos Transform to Electron Neutrinos



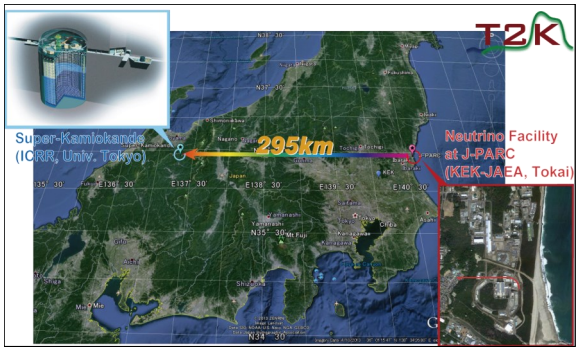
At the European Physical Society meeting in Stockholm last July, Thomas Kutter and Martin Tzanov's international T2K (Tokai-to-Kamioka) collaboration announced definitive observation of muon neutrino to electron neutrino transformation. In 2011, the collaboration announced the first indication of this process, a new type of neutrino oscillation; now with 3.5 times more data this transformation is firmly established. The probability that random statistical fluctuations alone would produce the observed excess of electron neutrinos is less than one in a trillion. Equivalently the new results exclude such a possibility at a 7.5 sigma level of significance. This T2K observation is the first of its kind in that an explicit appearance of a unique flavor of neutrino at a detection point is unequivocally observed from a different flavor of neutrino at its production point.

T2K uses a muon neutrino beam produced in the Japan Proton Accelerator Research Complex (J-PARC) at Tokai on the east coast of Japan. The neutrino beam is monitored by a "near detector" at Tokai and aimed at the 50 kton SuperKamiokande underground water Cerenkov detector in Kamioka near the west coast of Japan, 295 km away from Tokai. An analysis of the data from SuperK in coincidence with the neutrino beam shows that there are 28 electron neutrinos compared to 4.6 events expected without the new process.

Neutrino oscillation is a manifestation of a long range quantum mechanical interference. Observation of this new type of neutrino oscillation leads the way to new studies of charge-parity (CP) violation, previously only observed in quarks. CP violation in the neutrino sector in the very early Universe may be the reason that the observable Universe today is dominated by matter with no significant antimatter. Now with T2K firmly establishing $\nu_u \rightarrow \nu_e$ oscillation with its sensitivity to CP violation, a search for CP violation in neutrinos becomes a major scientific quest. T2K expects to collect 10 times more data in the near future, including data with an anti-neutrino beam.

T2K was constructed and is operated by an international collaboration. The current T2K collaboration consists of over 400 physicists from 59 institutions in 11 countries (Canada, France, Germany, Italy, Japan, Poland, Russia, Switzerland, Spain, UK, and the US). At LSU, it involves Kutter, Tzanov, postdocs Oleg Perevozchikov, Jonathan Insler, Flor de Maria Blaszczyk , and students Chris Greenley, Jiein Yoo, and Corey Myers . The T2K neutrino oscillation result was named one of Discover Magazine's top 100 science results in 2013.

The group is also involved in work for a follow-up experiment, the Long Baseline Neutrino Experiment (LBNE), which will send a neutrino beam from Fermilab to the Sanford Underground Research Facility (SURF) in South Dakota. LBNE will have better sensitivity to an asymmetry between ν and $\bar{\nu}$ and the ordering of neutrino masses (the "mass hierarchy"), and will search for nucleon decay.



One Step Closer To the First Spin Transistor

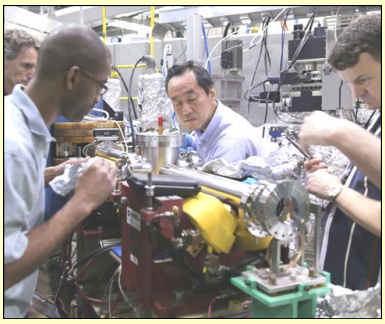
The research of Tijiang Liu, Joseph Prestigiacomo and Philip Adams is getting us one step closer to the first ever spin transistor. The development of a magnetic analog of the transistor has been a long-term goal of spintronics. Spintronic devices use the spin of the electron in addition to its charge to transmit and convene information. In contrast to semiconducting field-effect transistors (FET), which use gate-controlled electric fields to modulate the current, a magnetic FET would use a gate to modulate the magnetism of a thin magnetic film. Adams' team has demonstrated that the proximity-induced exchange field in ferromagnetic-paramagnetic bilayers can be modulated with an electric field.

Smart Radiation Therapy to Treat Cancer

Multipole Wiggler
Courtesy of CAMD

New Approach to fighting Cancer

Our medical physics faculty is teaming up with the Center for Advanced Microstructures and Devices (CAMD) to develop a new approach to fighting cancer. This treatment, Auger Electron Therapy, uses a drug with a high atomic number, like iodine, that attaches to the DNA of cancer cells and marks them as a target. When X-rays interact with these atoms they produce a short-range cascade of electrons which eradicate only the targeted genetic material. Current radiation treatments, on the other hand, can effectively eradicate cancer cells, but also cause damage to nearby healthy cells. "This type of treatment is very futuristic because we are going to rely a lot on people to develop drugs," said Kenneth Hogstrom, Physics & Astronomy professor emeritus. The research will use the synchrotron at CAMD to generate X-rays at specific wavelengths tuned to the atoms being used. Funding is provided by a $2 million Dept. of Defense grant to study Auger therapy, including development of a new biomedical radiology beamline at CAMD, coupled with a $1.26 million National Science Foundation grant to CAMD itself that added a new multipole wiggler.



Multipole Wiggler
Courtesy of CAMD

Accolades

Physical Review X

Jorge Pullin is the founding editor of Physical Review X (PRX), published by the American Physical Society. PRX is APS's online-only, fully open access journal. It is a highly selective peer-reviewed journal that aims to publish, as timely as possible, exceptional original research papers from all areas of pure, applied, and interdisciplinary physics. PRX's mission is to bring innovative and important results to the broad science and engineering communities under its open access publishing model which gives readers anywhere in the world free access to its full content. PRX has recently been assigned an impact factor of 6.711 by Thomson Reuters, the highest for any open access journal in physics.

Accolades

- David Young and Brad Schaefer were named Alumni Professors
- Jeff Blackmon receives Distinguished Faculty Award
- Mike Cherry was appointed Roy P. Daniels Professor
- Mark Wilde has received an NSF CAREER Award

Blackmon

Cherry

Schaefer

Wilde

Young

Gabriela Gonzalez

Woman Physicist of the Month

Prof. Gabriela Gonzalez was named by the APS as the 'Woman Physicist of the Month' for January. The award was for her leading role with LIGO, both as the current Spokesperson of the LIGO Science Collaboration and the lead for the working groups on detector characterization and compact binary coalescence detection.

The APS citation states: "Gabriela Gonzalez, Professor of Physics and Astronomy at Louisiana State University, is currently serving her second term as the Spokesperson for the LIGO Scientific Collaboration. In this position, she oversees the work of over 900 scientists from 86 institutions and 17 countries, representing the Collaboration professionally to the scientific community and to the public. In the years before being elected as LSC Spokesperson, Gonzalez led the LIGO working group on detector characterization (instrumentation) and the working group on seeking gravitational waves from compact binary coalescences (data analysis), and held countless scientific and administrative positions in the LSC. What isn't always as visible is the time and attention she invests in the people around her. Once you have come into her sphere of influence, she'll always have time for you and care for you as a whole person — both as a physicist and a unique individual.

Through her demonstrated excellence in experimental instrumentation, data analysis, student advising, and education and public outreach, the LIGO Scientific Collaboration has grown and is scientifically thriving. The list of Dr. Gonzalez's accomplishments would not be complete without a mention of her efforts to promote higher participation of women and underrepresented groups in the field. Under her leadership, the Collaboration has endorsed a statement to recognize the importance of diversity and pledge to work to increase the numbers of women and under-represented minorities in the Collaboration, appointed an LSC Ombudsperson office to serve the needs of the Collaboration, and created a working group charged to propose an action plan for improving diversity and further promote cultural and gender inclusiveness in the Collaboration.

Gonzalez is a fellow of the APS, the International Society of General Relativity and Gravitation, and the Institute of Physics. She has been awarded the APS Edward A. Bouchet Award (2007) and Woman in Physics Lecturer by the Australian Institute of Physics (2001)."

Singh Wins Vainu Bappu Gold Medal

Singh

Prof. Parampreet Singh has just been awarded the Vainu Bappu Gold Medal for his research on Loop Quantum Gravity. The Astronomical Society of India awards the Professor M. K. Vainu Bappu Gold Medal with the objective of promoting knowledge of Astronomy and Astrophysics and honoring the contributions made by young scientists, normally not beyond 35 years of age, from any nationality and any part of the world. The award is given at intervals of two years. The Gold Medalist is required to deliver the Vainu Bappu memorial lecture at a meeting of the Society. Previous winners include the 2011 Nobel Prize winner Brian Schmidt and renowned Cambridge and Caltech professors George Efstathiou and Sri Kulkarni.

Prof. Singh (Param) is working on a reconciliation between Einstein's General Relativity and Quantum Mechanics, with the theory being called Loop Quantum Gravity. In this model, space itself is discrete and quantized, with the points being connected as an extremely fine fabric of loops creating a spin foam with characteristic scale size 10^{-35} meters. In particular, Param is looking at the implications for cosmology and the origin of the Universe. His work has opened up the possibility that the usual Big Bang was actually a "Big Bounce", where there was a Universe *prior* to the Big Bang. That is, our Universe might not have originated as a singularity with nothing before it, but rather originated from an earlier collapsing Universe that 'bounced' through a time of incredibly small and hot conditions, with the after-time acting much like the usual Big Bang. Importantly, Param and Prof. Ivan Agullo are working out the observational consequences of this Loop Quantum Gravity cosmology, and they are saying that they will soon have distinct predictions for the Cosmic Microwave Background and for the clustering of galaxies that will soon be testable.

College of Science Hall of Distinction

Congratulations to both Ball Professor emeritus Arlo Landolt and 1989 Physics & Astronomy alumnus Keith Comeaux for being inducted into the LSU College of Science Hall of Distinction

Landolt

Arlo Landolt graduated from Miami University in Oxford, Ohio in 1955 as a double major in mathematics and physics, and later received a doctoral degree in astronomy from Indiana University in 1963. While pursuing his PhD, Landolt became a member of the first group to winter over at the International Geophysical Year's Amundsen-Scott South Pole Station in the Antarctic. He served as the group's aurora and airglow scientist studying the Aurora Australis, or Southern Lights. Landolt joined the faculty of the LSU Department of Physics & Astronomy in 1962. He was instrumental in the development of the astronomy group within the Department to international status. Renowned throughout the astronomical community for his discoveries, astronomers and physicists worldwide continue to use his series of papers which established the "Landolt Photometric Standard Stars;" his standard stars are among the most heavily used photometric standards throughout the globe. Landolt has received more than $4.5 million in grants and has published more than 100 peer-reviewed papers. He was named LSU Ball Family Professor of Physics & Astronomy in 2002 and has had a number of sites named in his honor, including Mt. Landolt in the Antarctic, and the LSU Landolt Astronomical Observatory in Nicholson Hall. Landolt is an active member of the College of Science Dean's Circle and even in retirement, he maintains his research and funding, and continues to publish.

Keith Comeaux graduated from Louisiana State University in 1989 with bachelor's degrees in Mechanical Engineering and Physics. He later earned a master's degree and doctoral degree from Stanford University in Aeronautics and Astronautics. After graduation, he accepted a position at Hughes Space and Communications, which is now part of Boeing in El Segundo. While there, Comeaux helped develop the 702 spacecraft product line, one of the first commercial applications of ion propulsion technology in the space industry. In 2006, Keith's work caught the attention of NASA and he was asked to work at the Jet Propulsion Laboratory (JPL) on the Science Laboratory, the next-generation rover launched to Mars in 2011. On August 5, 2012, Comeaux was flight director for the successful landing of the Curiosity rover on Mars. After landing, he served as a tactical mission manager, responsible for surface operations and strategic planning to determine what the rover would explore and analyze next on Mars. Currently, Comeaux is the deputy manager of assembly, test and launch operations for a climate observation satellite being constructed at JPL for launch in November of this year. Comeaux was also named to the LSU Alumin Association Hall of Distinction.

Comeaux
Photo: LSU University Relations

Adapted from College of Science Website

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Joel Tohline Retires

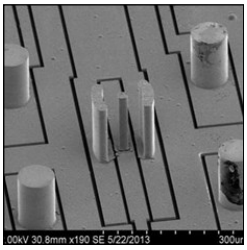
In December 2013, Alumni Professor and Director of the Center for Computation and Technology (CCT) Joel Tohline retired after a long and successful career spanning nearly 32 years at LSU. A native of Louisiana, he was educated at Centenary College and the University of California, Santa Cruz. After postdoctoral appointments at Yale and Los Alamos National Laboratory, Joel returned to Louisiana in 1982 as an Assistant Professor of Physics & Astronomy at LSU. He ascended through the tenured ranks reaching the distinction of Alumni Professor and Floating Point Systems Chaired Professor, and was an important contributor to the birth of LSU CAPITAL, which later became the CCT. Joel's love of research and teaching is reflected in the hundred scientific papers he authored and the fifteen doctoral students he advised at LSU. As an undergraduate teacher he was funny and inspiring, jumping from the "ground level" on to a chair and even higher on to a desk while "absorbing photons" of various colors thrown at him and returning them with gusto as he jumped down to lower levels. As a colleague and graduate mentor he was generous with his insights and guidance, which he delivered without pretense and with great humor. His even-tempered personality and scientific stature contributed to his success and have earned him the respect and support of his colleagues throughout his career. These qualities served him and LSU well in leadership positions such as Department Chair, Interim Director of LSU CAPITAL, Interim Executive Director of LONI and Director of CCT. While his many endeavors, carried out always with a smile, may have made him look favorably on retirement over the last couple of years, we are looking forward to his return as a friend and emeritus colleague after he has had time to chill for a few months.

Tohline

CAMD Microstructures to be Used in Nobel Laureate's Research

Dustin Hite joined CAMD in 1995 as a Research Associate, and his experiences there led him to expand his horizons by joining the department's graduate program. When he graduated in 2001 from LSU with his Ph.D., he had no idea that his research interests would place him in the laboratory of a Nobel Laureate. He was interested in surface interactions with nearby laser-cooled atoms – atoms so cold that each behaved as a single quantum-mechanical system, whose properties could be used, among other things, to make the world's most precise atomic clocks.

In 2012, his group leader at the National Institute of Standards and Technology (NIST) in Boulder, David J Wineland, shared the Nobel Prize in Physics with Serge Haroche of the École Normale Supérieure in Paris for their "ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems." Their labs continue to study these systems since they are thought to be a potential basis for the new field of quantum computing, which would enable calculations much faster and more complicated than current computers allow.



One way to measure these quantum properties is to use surface-electrode traps to confine ionized atoms and measure their response optically or to applied electric or magnetic fields. The stylus trap shown in the figure is a microstructure fabricated at CAMD, where the ion is suspended over the central electrode, confined by an rf field. The four corner-posts allow for a dc electric field to precisely adjust the ion's location. Sandia National Lab assisted the NIST team with making the first versions of this ion trap, but taller microstructures were required, so they enlisted CAMD to build the next generation, shown in the micrograph, above.

Hite

Republished from CAMD website http://camd.lsu.edu/CAMDResearchHite.htm .

Honorary Doctorate

U.S. Air Force Maj. Gen. Jasper Welch, a 1952 graduate of our department and member of the National Academy of Engineering, received an honorary doctorate and spoke at LSU's 280th Commencement in May 2013.

Maj. Gen. Jasper Welch
LSU Media Center

Physics & Astronomy Alumni

Please help us update our alumni database. Take a few minutes to respond with news about yourself to be included in our Alumni database. The Department of Physics and Astronomy maintains a database of all our alumni - Ph.D., M.S. and B.S.

The following information is needed and can be submitted by email to alumni@phys.lsu.edu or visit us on the web - http://www.phys.lsu.edu/dept/alumni

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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 to make a vital investment in the future. Donations for the benefit of the Department of Physics and Astronomy will be used to enhance our teaching program and facilitate scientific discoveries that shape the future.

If you would like to make a tax-deductible gift for the benefit of the LSU Department of Physics and Astronomy, please complete this form and return it with your check. Your contribution check should be written payable to: ***LSU Foundation—Department of Physics and Astronomy*** and can be mailed to: ***Michael Cherry, Chair, Department of Physics and Astronomy, Louisiana State University, 202 Nicholson Hall-Tower Drive, Baton Rouge, LA 70803-4001***. If you prefer to use a credit card for your donation, you may either fill in the details below, or you may submit your gift online by visiting http://www.phys.lsu.edu/newwebsite/endowments/index.html.

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