



LAWRENCE
UNIVERSITY
APPLETON, WISCONSIN

Issue 3 Fall 2013

Department of Physics

Collective Behavior

Distinguishing the physics major from the sea of liberal arts graduates.

LU physics notes:

- Doug Martin received a three-year \$200,000 grant from the National Science Foundation for a project titled *Connecting microtubule mechanical and structural properties using a novel millimeter-length gliding assay*. He was also tenured and promoted to the rank of Associate Professor in 2013.
- In 2012, Emeritus Professor David M. Cook was named a Fellow of the American Physical Society, a distinct honor he now shares with his colleague, John Brandenberger. Very few undergraduate physics departments have two APS Fellows!

Letter from the Chair

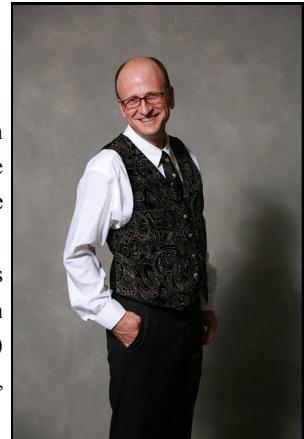
The 2013-14 academic year marks a new era for Lawrence University with the arrival of the institution's 16th president, Mark Burstein.

There are new faces in the Physics Department as well [Fleshman and Mauro ('05), see below] as we continue to push the excellence of our program forward. Over the past year:

- We were assisted by the Physics Advisory Committee, composed of LU alumni Bob Hanisch ('76), Todd Thompson ('97, see profile below), Chuck DeMets ('82), and Angela Kopp ('01). This high-powered team

of alumni visited in April 2013 and provided an extremely helpful review of the Department.

- The Lawrence Physics Workshop in 2013 adopted a *modern optics* theme and helped lead ten students to choose Lawrence this year.
- We benefited in 2012-13 from visits and talks by former LU Fellow, Joan Marler (now at Clemson University) and alumnus, David Meichle ('10, now at University of Maryland). We look forward to connecting with more alumni and friends of the Department in the coming year.



Matt Stoneking
Professor and Chair of
Physics

Departmental News: Student Accomplishments

Student awards for 2012-13:

Brackenridge Prize: Michael Van de Graaff ('14)

Departmental Service Award: Aaron Wright ('13)

Research Award: Karl Mayer ('13)

S.I.N. Prize: Jack Dempsey ('14)

Five students received BA degrees in June 2013 with a major in physics and two with a physics minor. Applications for admission to graduate or engineering programs by this cohort were successful at Colorado, Wisconsin, USC, Montana State, and Washington University.

Students made research presentations at meetings of the Optical Society of America (Rochester, NY), APS-Division of Plasma Physics (Providence, RI) and the Midstates Consortium Symposium (St. Louis, MO). Lu Yu ('12) and Brian Van Hoozen ('12) were coauthors with Doug Martin on a publication in the *Journal of Visualized Experiments*.



2013 physics graduates with department faculty and staff.

Nine students participated in the Summer Research Program on campus in 2013; two students performed research at the University of Twente with Jennifer Herek ('90), another was at Colorado with Cindy Regal ('01), and two more did REU projects (Caltech and Oregon).

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Modern Optics theme for LPW **2**

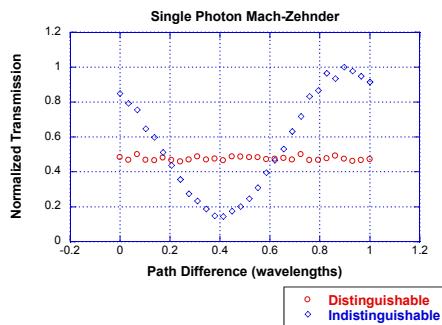
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A photon acts like it interferes with itself if the possible paths are indistinguishable; otherwise it acts like a particle.

A revolution is happening in the teaching of quantum mechanics and optics: single-photon experiments demonstrate the counterintuitive nature of quantum mechanics, from superposition (Schrödinger's cat) to entanglement (spooky

Modern Optics at Lawrence

action at a distance). Quantum optics experiments exploit spontaneous parametric down-conversion to create entangled pairs of photons that allow us to explore the peculiarities of quantum measurement. Students find that single photons can't be divided by a beamsplitter when they look at both output directions simultaneously (a version of the Grangier experiment). Yet when two beamsplitters are used in a Mach-Zehnder interferometer, single photons show the interference characteristic of wavefront splitting! Any addition to the apparatus that tracks the photon's path destroys the effect, but interference is restored by inserting a properly oriented polarizer (the quantum eraser) after the last beamsplitter (the figure shows interference when the paths are indistin-

guishable, and lack of interference when the paths are distinguishable). **Jeff Collett** and **Doug Martin** are incorporating modern optics across the Lawrence physics curriculum. We're recruiting high school students in the physics workshop using single-photon two-slit experiments, quantum erasers, and Fourier optics to free kittens from optical cages. In Quantum Mechanics, we're testing quantum interference and measurement interpretations using the Mach-Zehnder quantum eraser experiment. In Advanced Laboratory, students test an alternate version of the Bell inequality using entangled photons. We are working to integrate these experiments into the introductory modern physics lab to keep our curriculum truly modern.

Spotlight On Extra-solar Planets

One of the outstanding problems in planetary science remains the detailed formation of planets in our Solar System. The issue is of increased importance with the discovery of nearly 1,000 extrasolar planets over the last two decades. In fact, recent estimates for the total planetary population in the Milky Way alone reach into the billions! The main planetary body in our Solar System, and the majority of confirmed extrasolar planets so far discovered are massive,

Jupiter-like gas giants, and yet, scientific debate continues over how these large objects formed and evolved.

Associate Professor **Megan Pickett** has studied the problem of giant planet formation since the mid-1990's, beginning in graduate school at Indiana University Bloomington and NASA's Ames Research Center in Mountain View, California. Today, she and her students continue her work on how dynamic processes in the

early solar system using a state of the art Solar System simulator. Their work, conducted using local and national computing resources, focuses on how spiral arms, which are seen in young solar systems, can lead to planet formation, and how those planets might affect any smaller, potentially life-bearing planets like the Earth like some of those detected by the presently suspended Kepler Spacecraft mission.

Update on Faculty Changes



Bobby Fleshman (left) joined the LU physics department in August 2013. LU alumnus, **Nick Mauro** (right, LU '05) returned to Lawrence as a Visiting Assistant Professor in September 2013.

In the spring of 2013 we wished matter and material physics. As a (Ph.D.). His research area is farewell to **Rob Salgado** and post-doctoral scientist he developed and constructed the Neutron netospheres. He has recently **Pasad Kulatunga**. Rob will be teaching at UW-Lacrosse, and Electrostatic Levitation facility for understanding the Pasad left for Dubai where he will studies of liquid atomic structure interaction between Saturn's head the physics program at International Horizons College. and dynamics in metallic glass-forming alloys at Oak Ridge National Laboratory. He and his wife Emily (LU '04) return to Appleton Master Brewers Program at the

this September are **Nick Mauro** and **Bobby Fleshman**. Dr. Mauro with their children, Gabe (1) and Emily (LU '04) return to Appleton Master Brewers Program at the and **Bobby Fleshman**. Dr. Mauro with their children, Gabe (1) and Emily (LU '04) return to Appleton Master Brewers Program at the University of California – Davis. who received his Ph.D. from Dr. Fleshman has degrees from Oklahoma City University (B.S.) professor in the Lawrence Washington University. His research interests are in condensed and the University of Oklahoma Chemistry Department.

Alumna Profile: Susan Cook ('76)

Lawrence physics graduates contribute in fields far removed from the subject of their undergraduate studies. **Susan Cook's** career trajectory provides an excellent example.

After graduating in 1976 and taking the summer to backpack through Europe with other Lawrentians, Sue went to work for Control Data Corporation in Chicago. Her focus: helping their clients solve complex computational problems using Control Data's time sharing services and big vector processors. She went on to the Kellogg School of Management at Northwestern University for a Masters in Business Administration in 1981. She says, "Everyone in business school was

focused on consumer products and financial services. I was one of the few interested in combining technology and business. My background in physics combined with business made for a unique combination."

Hewlett-Packard soon recruited her to their Palo Alto headquarters, and she spent 22 years at HP in a variety of positions, ultimately as VP of Global Operations. Along the way she managed groups in marketing, services, and software, along with corporate engineering and marketing, and part of the global supply chain. "I always focus on understanding what customers want

to do with technology, and help translate between the customer and the product development teams. Don't underestimate the importance of what you learn in a liberal arts education, especially about communications, writing and culture."

After a sabbatical from her career to focus on family she, along with some colleagues, started Spearfish Innovation, a consulting business that helps innovation teams bring new products and services to market.

Sue reflects, "I never thought this would be the direction my career would take when I was at Lawrence. But I do know that having



Susan Cook was VP of Global Operations at Hewlett-Packard among other roles.

my physics degree made a big difference in getting a job, in opening some doors along the way, and now in working with startups and executives."

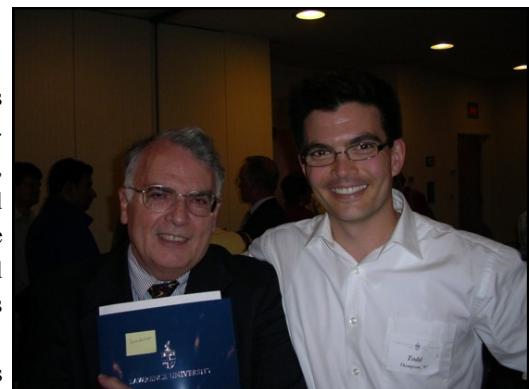
Alumnus Profile: Todd Thompson ('97)

Professor **Brandenberger** vividly recalls the day senior physics and philosophy major, **Todd Thompson**, after months of hard work, finally succeeded in producing sonoluminescent pulses by resonantly driving acoustic cavitation in a flask of water. He burst from the darkened lab to proclaim his success to one and all in Youngchild Hall in the manner of Archimedes's discovery of the law of buoyancy. Those who have heard him speak on his scientific work in the years since he left Lawrence to pursue a career in theoretical astrophysics will confirm that he continues to be readily excited by new discoveries.

Thompson's path from Lawrence took him to the University of Arizona. In Tucson he worked on problems associated with core

collapse supernovae for which he received his Ph. D. in 2002. Todd then landed two prestigious post-doctoral fellowships in sequence, bearing the names Hubble (at Berkeley) and Spitzer (at Princeton) before the Ohio State University Department of Astronomy lured him to a tenure-track faculty position. He is now an associate professor in that department. Todd, his graduate students and collaborators publish regularly in *Astrophysical Journal* and other prominent publications on diverse theoretical topics in astrophysics from planet formation to neutron star formation to the origin of galactic winds and many others. For example, a recent paper in the *Monthly Notices of the Royal Astronomical Society* is titled,

"Gas giants in hot water: inhibiting giant planet



Todd Thompson (right), Associate Professor of Astronomy at Ohio State University with John Brandenberger.

formation in dense star clusters through cosmic time."

Todd is married to **Katra Byram** (LU '97) who is assistant professor in the Department of Germanic Languages and Literatures. They have two children (6 and 3).

Other Alumni News

Michelle Milne ('04) completed her Ph.D. at Washington University in St. Louis and is now Assistant Professor at St. Mary's College of Maryland.

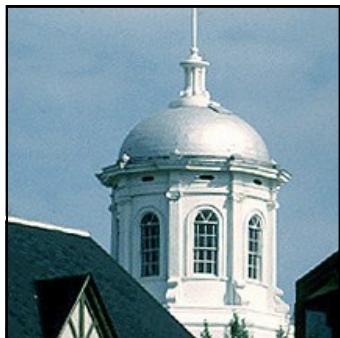
lege.

Stefany Sit ('08) received her Ph.D. from Miami University of Ohio and is now a Clinical Assistant Professor in the Department of Earth and Environmental Sciences at the University of Illinois—Chicago.

LU physics alumni, update us on changes in your career or activities:

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The Department of Physics at Lawrence University strives to be a truly distinctive undergraduate physics program of the highest quality. By featuring specialized signature programs in areas of faculty expertise we engage students in the practice of physics across the curriculum and develop their ability to use contemporary tools of theoretical, experimental, and computational physics. The impact of signature programs extends from recruiting of new students to enriching senior experience projects. We aim to attract diverse and eager students, to transform their abilities and aspirations, and to open doors for them to participate as professionals in training and eventually enter the ranks of the next generation of scientists. In practicing physics, faculty members continually engage in scholarly activities that involve students in collaborative physics research in order to maintain our professional vitality, contribute new knowledge to the discipline, and enrich the curriculum. Ultimately, because physics comprises an important component of the liberal arts, we aim to communicate a coherent scientific world view to all members of the Lawrence community.

www.lawrence.edu/academics/study/physics

Staff Focal Point: LeRoy Frahm

"The right place, the right time!" - often heard with something successful. Two things come to mind after 38 years here: Lawrence Physics and Heathkit. Strange or interesting? Let me share.

In decades past, when there was a keen interest in electronic instruments, there was Heathkit with low cost kits, and our budget was small, so Lawrence physics students benefited from using those oscilloscopes, generators and volt-ohm-meters. As time passed, the advent of digital electronics for students was about to arrive. We flipped the Heathkit inventory to purchase new solid-state Tektronix scopes.

With growing interest in Digital Electronics, **David Cook** and **John Brandenberger** launched a Digital Electronics workshop weekend to It's "the right place, the right time"

attract bright students to pursue physics; many physics students benefited from those weekends and discovered Lawrence physics at the same time.

Just as the Heathkits came and went, the Digital Electronics workshops came and went, replaced by a new kid on the block for workshops – Lasers! The workshops continued to evolve again over time. The well-executed workshops continue today in their third decade, with an enviable record as the only department with this sustained achievement! Many more students benefited from the workshop, discovering physics here, and going on to do exciting things.

Some things change, but bright students are still looking for that "Eureka" feeling of a hands-on experience, which propels them further in physics. It's "the right place, the right time"

moment!

The Nation faces a need to improve science education. We hear many solutions prescribed for this Heathkit? My grandfather gathering storm. Not every department or institution can do everything to solve this issue, but I believe we still have many bright students seeking to discover the experience of a physics workshop week-department at the same time. if you pause and listen, you may hear a student say, many solutions prescribed for this Heathkit! What do you say to the student looking for a place to study physics today? I'd tell them what I'm thinking; it's about "the right place, the end, and discover a little physics right time". The rest is history.

On the current horizon are significant efforts in Innovation in physics to challenge the bright mind and now the new kids on the block are things like Arduino kits and little companies like Sparkfun hosting workshops for teens!

We have been giving students a hands-on workshop experience for years. **Bruce Brackenridge** may never have imagined what would happen when he purchased those first Heathkits, and David and John may never have imagined the work-



LeRoy Frahm, staff member in the Physics and Psychology Departments for 38 years.



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