Issue 5 Spring 2016

LAWRENCE UNIVERSITY
APPLETON, WISCONSIN

Department of Physics

Collective Behavior

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

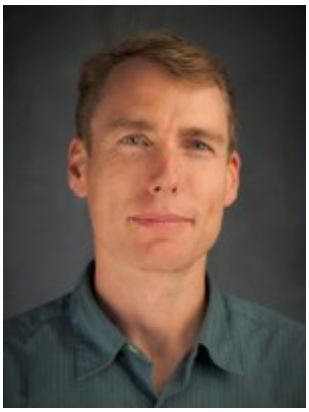
LU physics notes:

Lawrence University faculty members are eligible for one year of sabbatical every seven years:

- **Doug Martin** was on sabbatical at the University of Warwick, United Kingdom for the 2014-2015 year.
- **Matt Stoneking** was at the Max Planck Institute for Plasma Physics in Germany for his sabbatical (Jan.—Nov. 2015).
- **Jeff Collett**'s sabbatical is at the University of Wisconsin—Madison (2015-16).
- **Megan Pickett** will go on sabbatical at the University of Washington for the 2016-17 year.

Inside this issue:

Letter from the Chair



Douglas Martin, Assoc. Professor and Chair of Physics

Dear alumni and friends of the Lawrence University physics program: This annual communication comes a bit later than in previous years, but it describes some of the activities we've been so excited to engage in over the past year. Two faculty have returned from sabbaticals and we've had the outstanding service of two visiting faculty members. We celebrated 40 years of service from LeRoy Frahm, the life of Gene Peterson, and the interplay between theory and experiment in our own research. Eight new alumni joined graduated this past June; we're delighted to report their final project titles below.

Best regards, Douglas Martin

Project Titles for 2014-15

Senior Experience Project Titles for 2014-15

Amber Betzold *The Teapot Effect: An Experimental and Computational Investigation*

Ashley Coenen *Exploring the Chaotic Behavior of the Damped Driven Pendulum*

Sanfer D'Souza *RGBD SLAM: Using an XBOX 360 Kinect Sensor for Scene Reconstruction and Camera Localization*

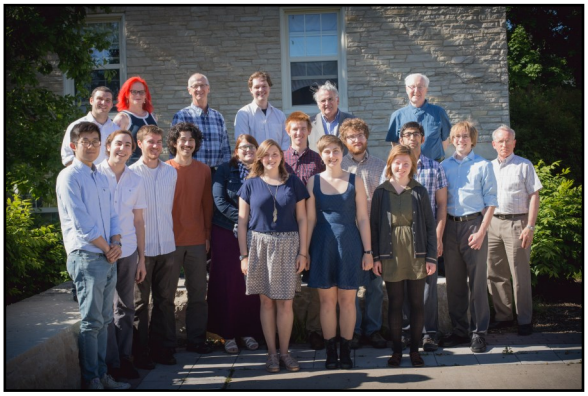
Drew Doares *Novel Asymmetry Modes in the Lawrence Non-neutral Torus II*

David Kozloff *Hardy-Bell Experiment*

Tianchu Alex Liang *A Monte-Carlo Simulation on Self-binding Polymers*

Tanner Rasmussen *Wireless Power Distribution*

Erika Roedl (3-2 Egr.) *The crystal structure and potential for diffusion bonding of $Ti_{34}Zr_{11}Cu_{43}Ni_8$ as a glass to the crystalline Ti-6Al-4V super alloy*



2015 physics graduates with department faculty and staff.

Student awards for 2014-15:

Brackenridge Prize: Rachel Lindley
Departmental Service Award: Erika Roedl
Research Award: Daniel Martinez Zambrano
S.I.N. Prize: Clayton Ristow and Cody Poole

Update on Faculty Changes

Sara Chamberlin joined the physics department as a Visiting Assistant Professor in September 2015.

After two years as a visiting assistant professor at his alma mater, **Nick Mauro** '05 was snatched up for a tenure-track faculty position at North Central College in Naperville, Illinois. It is noteworthy that recent former Lawrence visiting faculty members and fellows are now tenure-line faculty at, in addition to North Central College, the University of Seattle, Marquette University, Lane Community College (OR), Clemson University, and Lewis and Clark College.

We welcomed a new faculty member to the physics department in 2015. **Sara Chamberlin** received her bachelor's degree in physics from the University of Wisconsin—Eau Claire (2004) and her Ph.D. from the University of Wisconsin—Milwaukee (2011). Her area of scholarship is experimental condensed matter physics. In particular she studies the atomic surface structure of metal oxides using various diffraction techniques. She is a native Wisconsinite, having grown up in Wisconsin Rapids.

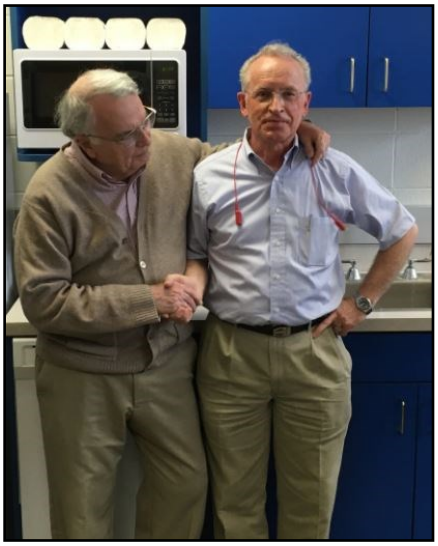
Staff Profile: LeRoy Frahm

This winter, Lawrence University President, **Mark Burstein** recognized Physics Department staff member, **LeRoy Frahm** for his long service to the institution. In 2015, LeRoy marked 40 years as a Lawrence staff member, all of that time with the Departments of Physics and Psychology.

There is no laboratory in the LU Physics Department, whether a faculty research lab (as well as Professor **Bruce Hetzler**'s psychology research lab) or a teaching lab, that does not run on equipment that LeRoy helped obtain, build or repair. The inventory of instruments in the department has been regularly augmented by his acquisitions from the Federal Surplus Property program.

As generations of physics students have learned during their work in the physical electronics course, the advanced laboratory course, their summer research or senior projects, Mr. Frahm is a tremendous resource, and is generous with his time and expertise when it comes to working with students and faculty.

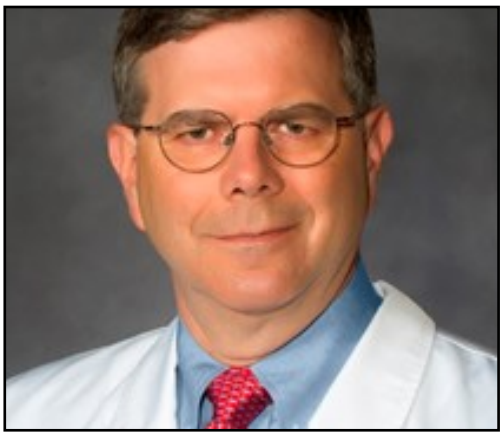
LeRoy is a veteran (Vietnam) and served many years in the Air Force Reserve, including active duty in Kuwait (2003). He is currently a volunteer with Employer Support of the Guard and Reserve and is a sought after subject matter expert on the Uniformed Services Employment and Reemployment Act (USERRA). LeRoy and his wife, Rose, are lifelong Appleton residents.



LeRoy Frahm (right) (with John Brandenberger) has been a staff member in the Department of Physics since 1975 .

They raised their two children, Ellery and Erika in Appleton, and are now frequent hosts for their two grandchildren, Liev and Sylvie.

In Memoriam: Gene Peterson ’76



Gene Peterson ’76

Gene Peterson (LU Physics ’76) died on November 20, 2015 at his home in Richmond, Virginia just a few months after contracting a particularly aggressive and uncommon form of bone cancer. Gene had relocated to Richmond from Seattle just two years earlier to become the chief safety and quality officer at the Virginia Commonwealth University Health System and associate dean for patient safety and quality care at the VCU School of Medicine.

Gene and I, along with Sue Cook and a few others, were close friends (and sometimes competitors!) in the Department of Physics at Lawrence. Gene and I were lucky to spend a term at the London Center (then the Lexham Gardens Hotel) under the tutelage of Bruce Brackenridge, who took us on wonderful tours of Newtonian England. We were amongst the initial members of the Loyal Society of S.I.N. (Sir Isaac Newton, of course; “Up with gravity, down with levity!”). There was no shortage of levity, however, as we explored the three cities (London, Cambridge, Grantham) each having three sites of historical significance in Newton’s life (one of which, at the time, was occupied by a Turkish bath which we were obliged to try out). While in London Gene did an analysis of the British five-pound note, which showed an illustration from Newton’s *Principia*. Unfortunately, the British Mint had copied the illustration from an incorrect edition. Gene and Bruce notified the authorities, and I believe that later printings of the banknotes had the correct figure.

After Lawrence Gene attended the University of Leeds in the UK on a Marshall Scholarship. I think he charmed the selection committee with his stories of raising bees on the family farm in Delafield! He completed a PhD in physical chemistry from Leeds (1980) and an MD from the University of Chicago (1982). Gene’s medical career led from anesthesiology gradually into health administration, focusing on care quality metrics and safety.

Gene is one of the LU Physics Department’s major success stories, and it is sad that we have lost him so early. Gene contributed generously to the Physics program in appreciation for the excellent basis it provided for his further education and career, but also in recognition of the wonderful faculty and staff who, for both of us, became life-long friends. Those wishing to contribute to LU Physics in Gene’s memory are asked to contact Erin Chudacoff (erin.h.chudacoff@lawrence.edu) for details on the process.

Bob Hanisch ’76
February 2016

Bob Hanisch, Gene Peterson, and Bruce Brackenridge at Grantham, fall 1974.

LU physics alumni: please update us on changes in your careers and activities:

douglas.s.martin@lawrence.edu

Sabbatical Report: Electron-Positron Plasma

Professor Stoneking (far left) with his colleagues outside the FRM II reactor in Munich, Germany (2015).

Plasma is notorious for the complexity of its dynamics; the ubiquitous presence of turbulence in space and laboratory plasma is a prime example of this complexity.

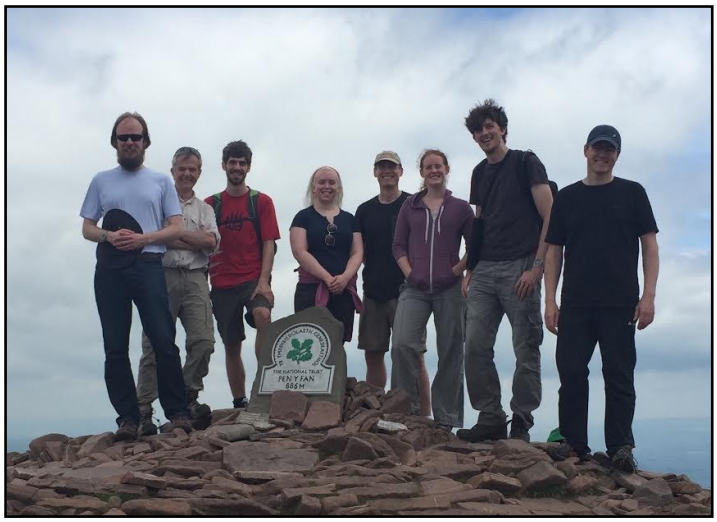
Max-Planck-Institut für Plasmaphysik
EURATOM Association

The mass difference (~1800X) between the charged constituents of plasma (ions and electrons) is the source of much of this complexity. A Positron Electron eXperiment (APEX) aims to produce a plasma with equal mass constituents—electrons and their anti-matter partners, positrons. Such a system might be called the "hydrogen atom" of plasma physics for its simplicity, and theory predicts particularly stable states and unique wave behavior for such plasma. The APEX team endeavors to trap and study electron-positron plasma in the magnetic field of a levitated superconducting coil. **Matt Stoneking** joined this project during his sabbatical year and helped conduct experiments at the FRM II research reactor in Garching, Germany in which positrons were successfully injected into the field of a permanent magnetic.

Sabbatical Report: Super-resolution Microscopy and Cell Division

CMCB
centre for mechanochemical cell biology

Douglas Martin spent the year at the Centre for Mechanochemical Cell Biology at the University of Warwick in the UK. The center's name indicates a group of ~ 40 students, post-docs, and faculty working at the interface of biology, chemistry, and physics to understand cells as the fundamental unit of life. Doug spent his time developing a new super-resolution microscope (a microscope that does an end-run around diffraction, which blurs images at the scale of the wavelength of light, about 500 nm), and using it to investigate the force-generating machinery involved in cell division (see scholarship report). The most exciting part? Bringing the technique back to Lawrence to work with students on new optical and biochemical physics.



Professor Martin (middle with hat) atop Pen Y Fan in the Breacon Beacons.

Focal Point: A Rewarding Theory

Readers of *Collective Behavior* are well aware of the critical interplay between theory and experiment in physics, and revel in those cases where innovative theorizing predicts unobserved phenomena. The reverse situation is also important, *i.e.* where newfound experimental results prompt theorists to test and/or modify existing theories. In most cases, the desire to "push back the frontiers of knowledge" provides sufficient *intrinsic* incentive for theorists to explore whether their prevailing theories can account for the new results. But occasionally the existence of an *extrinsic* reward helps generate the necessary interest and activity.

We report here such a case — in which a monetary prize helped incentivize theoretical activity in response to some new experimental results. The results in this case were acquired by a group of Lawrentians who amassed sixteen measurements of fine structure splittings in atomic rubidium using three-step laser excitation. Initially these measurements were completed and published by physics majors **Ryan Jung** (LU '02), **Cindy Regal** (LU '01), and **Michael Yakes** (LU '01) along with **John Brandenberger,** in 2002[1]. They hoped that their measurements would stimulate theoretical developments and lead to improvements in atomic theory. But alas, they didn't. The work was fine, but it failed to attract theoretical interest.

Then in 2009, **Gennady Malyshev** (LU '10) extended these measurements in rubidium. But once again, when published[2], these results failed to stimulate theoretical activity. Gennady was frustrated and complained that ". . . we don't have any theoretical results to which we can compare our measurements . . . ." In August of 2009, Gennady described the situation to **Dale L. Skran, Jr.,** who, along with Professor **Claudena Skran** and the Skran family, had provided Gennady's summer research stipend, enabling him to make his measurements. Now, it turns out, that Mr. Skran is an avid enthusiast for space travel, and he appreciates how prizes have been important in the space business — sometimes leading to important advances. Hence Mr. Skran suggested that Gennady's frustration perhaps called for a prize — a monetary award that would be given to any theorist who would consider the Lawrence results and determine whether current theory could account for them.

Thus in 2010, the Lawrence Department of Physics, with Mr. Skran's backing, announced to the physics community the existence of a $10,000 prize — the Dale L. Skan, Jr. Prize — which would be awarded to anyone who publishes a theoretical analysis of the Lawrence results. Several years passed with no takers, but eventually **Dr. Steven A. Blundell**, an Oxford-trained atomic theorist working in France, undertook the calculation. The Department was delighted to hear from him, and especially delighted when Dr. Blundell announced on 2014 that he had been successful — that by including some new approaches to current atomic theory he was able to account for the Lawrence results. Hence when Dr. Blundell's Physical Review article[3] appeared several months later, Lawrence promptly awarded him the full $10,000 Dale L. Skran, Jr. Prize, which Mr. Skran had so generously underwritten. Conclusion: extrinsic rewards sometimes provide important incentives. Do you readers of this newsletter ever find this to be true?

-by John R. Brandenberger,
Alice G. Chapman Professor Emeritus of Physics

[1] J.R. Brandenberger, C.A. Regal, R.O. Jung, and M.C. Yakes, *Fine-structure splittings in ^2F states of rubidium via three-step laser spectroscopy,* Phys. Rev. A **65**, 042519 (2002).
[2] J.R. Brandenberger and G.S. Malyshev *Fine-structure splittings in high-lying ^2F states of rubidium via three-step laser spectroscopy,* Phys. Rev. A **81**, 032515 (2010).
[3] S.A. Blundell, *Calculation of fine-structure splittings in high-lying ^2F states of rubidium,* Phys. Rev. A **90**, 042514 (2014).

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The Department of Physics at Lawrence University strives to offer 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. 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 to enter the ranks of the next generation of scientists. In practicing physics, we 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

Faculty Scholarship Report

Lawrence physics faculty have been active in scholarship during the past few years, resulting in the following peer-reviewed publications since the beginning of 2015:

- **J.A. Collett** and **Daniel Martinez Zambrano ('15)**, *Using dislocations to probe surface reconstruction in thick freely suspended liquid crystalline films,* Phys. Rev. E. **92**, 040501(R) (2015). This paper is notable for having a Lawrence student co-author.
- **J.R. Brandenberger** and **R.E. Lindley ('16)**, *Hyperfine structure in the 6 D-2(3/2) and 6 D-2(5/2) states of Rb-87 and Rb-85,* Phys. Rev. A , **91**, 062505 (2015). This paper also features the work of a student co-author, and see also the Focal Point on p. 5.
- H. Saitoh, J. Stanja, E.V. Stenson, U. Hergehahn, H. Niemann, T. Sunn Pedersen, **M.R. Stoneking,** C. Piochacz, and C. Hugenschmidt, *Efficient injection of an intense positron beam into a dipole magnetic field*, New J. Phys. **17**, 103038 (2015). See the Sabbatical Report.
- **J. Wagner**, G. Erdemci-Tandogan, R. Zandi, *Adsorptions of a branched polymer on rough surfaces: a model for RNA adsorption,* J. Phys. Cond. Matt. 27 495101 (2015)
- **J. Wagner**, R. Zandi, *The robust assembly of small symmetric nano-shells,* Biophys. J. 109 956-965 (2015) [arXiv:1312.4603].
- **S.E. Chamberlin**, I.H. Nayyar, T.C. Kaspar, P.V. Sushko, and S.A. Chambers, *Electronic structure and optical properties of* α*-*$(Fe_{1-x}V_x)_2O_3$ *solid-solution thin films,* Appl. Phys. Lett. **106**, 041905 (2015).
- Frauke Hussmann, Douglas R. Drummond, Daniel R. Peet, **Douglas S. Martin**, and Robert A. Cross, *Alp7/TACC-Alp14/TOG generates long-lived, fast-growing MTs by an unconventional mechanism,* Scientific Reports **6**, Article number: 20653 (2016). See the Sabbatical Report