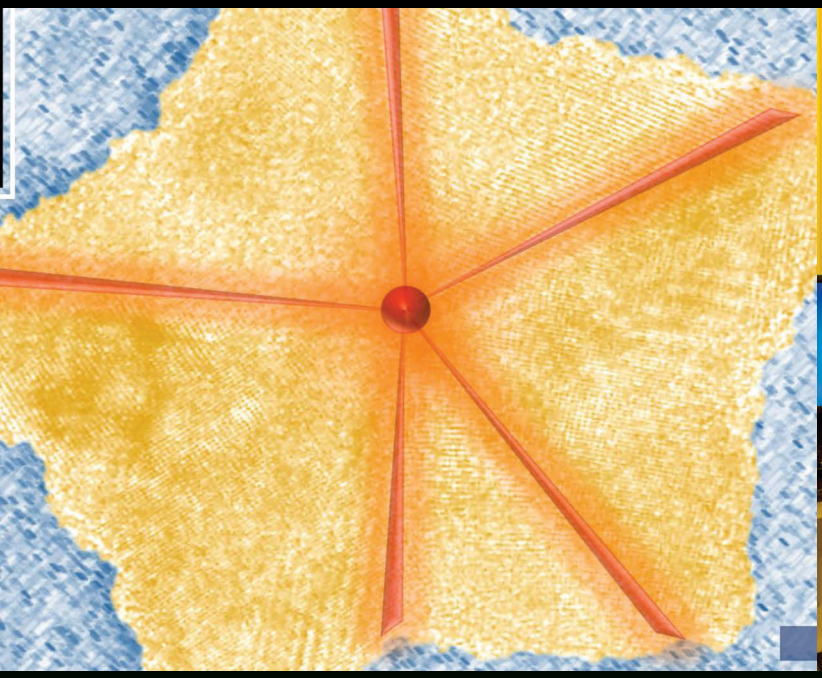
SPECTRUM

NO. 28 | SPRING 2018



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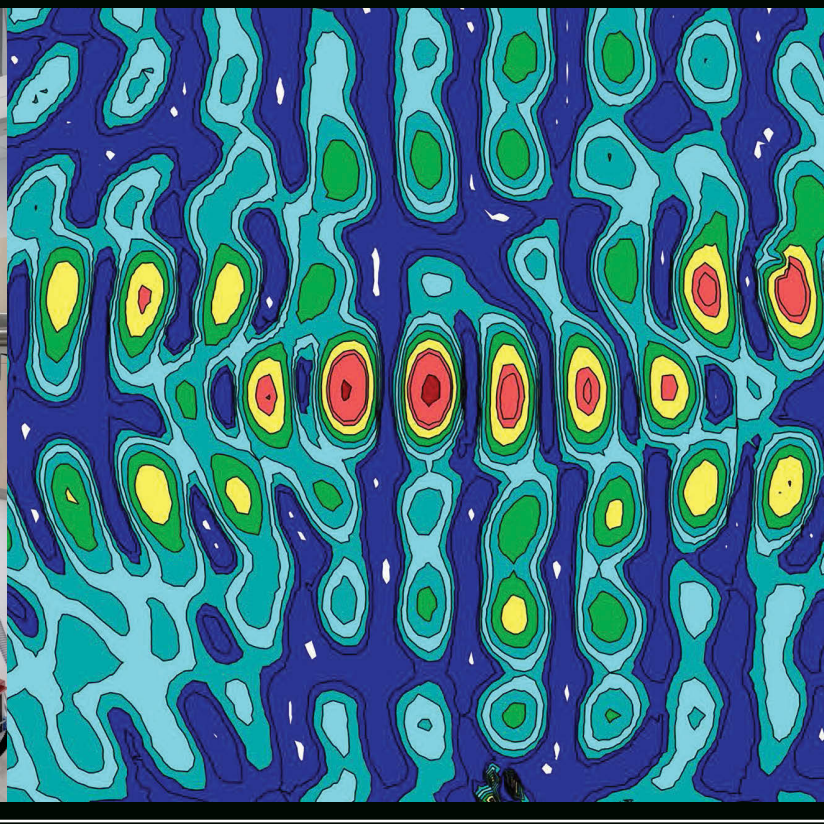
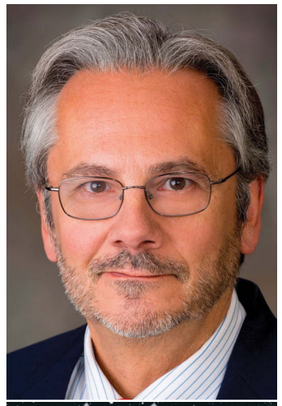


FOR THE ALUMNI AND FRIENDS OF THE DEPARTMENT OF PHYSICS & ASTRONOMY

FROM THE CHAIR

Space: The Final Frontier



Last time we shared news of reaching a new benchmark of $15.26M in annual external expenditures, maintaining a 20-year pace of doubling funding every 7 years [see *Spectrum* No. 27 (Fall 2015), pp. 1-6]. Leadership on a number of large interdisciplinary and multi-institutional grants, securing industry support for new centers, and identifying research projects relevant to the university's partnership with the United States Strategic Command as a University-Affiliated Research Center [see *Spectrum* No. 26 (Spring 2014), p.10] all contributed to that success. This issue we describe developments that build further on those accomplishments (see our cover story on p. 4).

At some point continued growth of any department will begin to see diminishing returns. We have no reason to believe we are there yet. We have, however, reached the point where planned, needed hires cannot be completed owing simply to lack of office and laboratory space.

How is that possible? Your building's practically *new!*

Shortly after Jorgensen Hall's Fall 2010 dedication [see *Spectrum* No. 25 (Fall 2011), p.2] all its faculty office spaces were assigned. A strategic plan to complete 4 unfilled lines created by retirements in the Department and to continue building our graduate research program required squeezing research faculty, postdocs, and graduate students into tighter and tighter quarters. In order to accommodate the then **72** (now **86**) graduate students, we worked with office furniture suppliers to select cubicles that would allow us to pack as many desks as possible into each and every student and postdoc area, exceeding the density in the architects' design (which had assumed **56** graduate students). Our success in securing grants meant we had many more postdocs than the head count taken in the building's early planning, so that postdocs now share offices with the same density as graduate students. We don't necessarily have the open space to allow graduate students who have completed coursework to move to offices adjacent to their labs. We frequently lack open desks to offer extended-stay collaborators, short-term visitors, colloquium speakers, our undergraduate researchers, or the many summer workers here to take advantage of our REU (Research Experiences for Undergraduates) and RET (Research Experiences for Teachers) programs. We temporarily accommodate them all by crowding furniture from inventory into the last remaining unassigned lab space (actually reserved for a future hire) and our conference rooms.

Jorgensen Hall's construction was funded through a State Legislature bond that designated the proposed complex as "replacement space." A strict interpretation of that phrase by administrators constrained architects to work within the square footage of usable space we held in Brace, Behlen, and Ferguson Halls and provided a budget unable to address even the anticipated needs of a highly successful and rapidly growing department (such as our goal to increase our graduate program to **90 - 100** students). With 18 faculty labs and 16 current AMOP and CMMP experimentalists (with the five HEP experimentalists sharing a common laboratory), we have severely limited options remaining for the 2 additional hires needed to complete our long-term strategic plan.

Room to Grow?

By design Jorgensen Hall does allow for expansion through possible additions to the building. The image on the next page, courtesy of Jerry Johnson (of the architecture firm Perkins+Will), shows what a two-story addition over the Instrument Shop (providing an additional 16,000 gross sq. ft.) would look like. In a review of the existing design, Perkin+Will's structural engineer concluded that while this addition might need some of the existing columns in the shop strengthened, the existing foundations are more than adequate without modification for an additional 1 or 2 floors. Perkins+Will's cost estimator recommended budgeting $220/sq. ft. (using 2010 data). At that rate the construction costs of each one-floor addition (8,000 gsf) would be $1,760,000 or $3.52 million for two floors; in either case, an additional $500K or so would be needed for project management and contingencies.

A two-story addition above the existing instrument shop is shown. The Voelte-Keegan NanoScience Research Center (not shown) would be out of view and to the left of this image.

For several years, together with the College of Arts and Sciences and the Office of Research, we have advocated for such an expansion to the University's Capital Project Planning team in the hopes of becoming part of UNL's next Campus & Landscape Master Plan. We have been advised, however, that to become a priority such projects require initial investments by major donors.

Meanwhile, even as we continue to strain near to bursting at the seams, we continue to make our case based on the record of success and productivity of the Department of Physics and Astronomy.

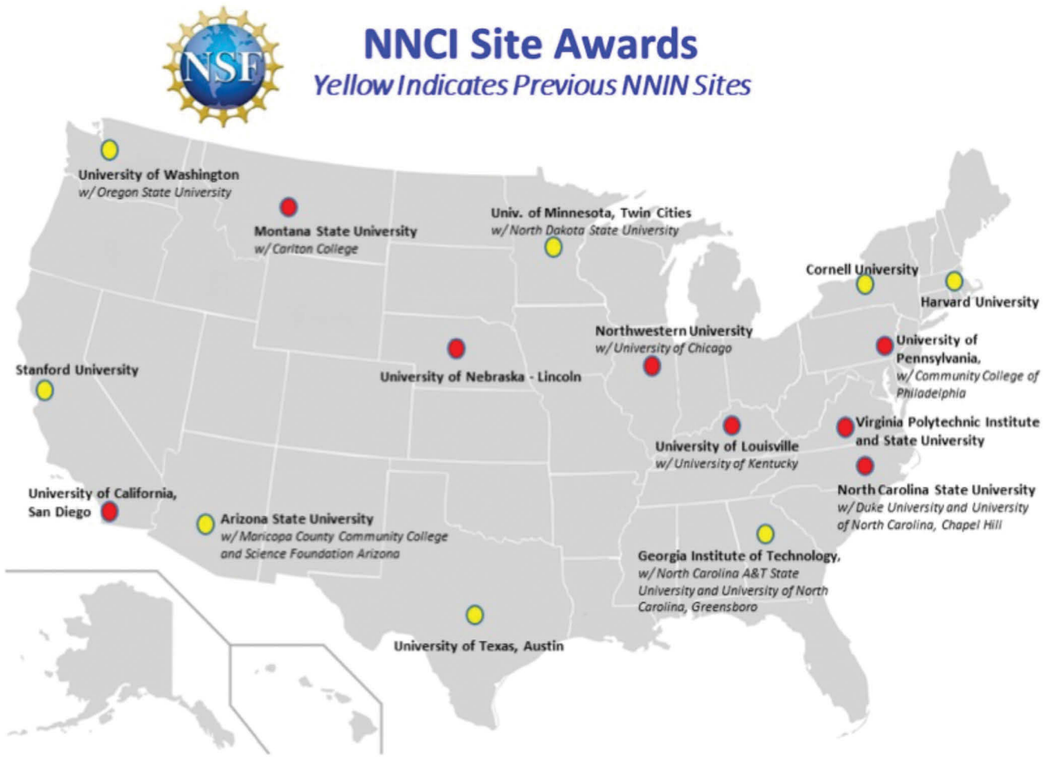
Sincerely,

Daniel R. Claes

Daniel R. Claes
Professor and Chair

NO. 28 | SPRING 2018 | UNIVERSITY OF NEBRASKA—LINCOLN | ANTHONY F. STARACE, EDITOR
KEN BLOOM, ALEXEI KOVALEV, AMANDA LAGER, ASSOCIATE EDITORS

Nebraska Develops Site of NSF's National Nanotech Network

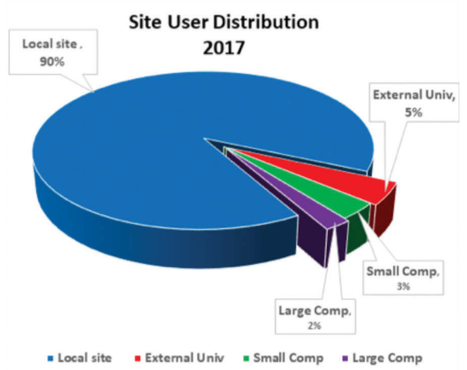


In Fall 2015, the Nebraska Center for Materials and Nanoscience (NCMN) was awarded a $3.5 million five-year grant from the National Science Foundation (NSF) to establish the Nebraska Nanoscale Facility (NNF), a site of the National Nanotechnology Coordinated Infrastructure (NNCI). NNCI's goal is to provide the nation with first-class facilities for synthesis, fabrication and characterization of nanoscale materials and structures, and to promote research, education and outreach in the field. The map above shows the NNCI sites, each of whose mission includes assistance to regional and national universities and companies. An important aspect of NNCI is that there are many collaborations between and among the various sites in both education and research, so that the network as a whole is much more than the sum of its parts.

According to **David J. Sellmyer**, George Holmes University Professor of Physics, who directs the new facility, "NNF arose from three earlier entities that provide a strong basis of support. These include the NCMN, which has about 90 faculty and $20 million per year of research expenditures, the Nanoscale Science and Technology Program of Excellence, which provides academic support for nine faculty, and the Voelte-Keegan Nanoscience Building that was completed in 2012 with federal and NU Foundation support. Facilities and equipment for research in nanoscience and nanotechnology are expensive, so it makes sense for NSF to provide support to the 16 strong national sites so they can efficiently assist other universities and companies to advance their research and economic-development goals."

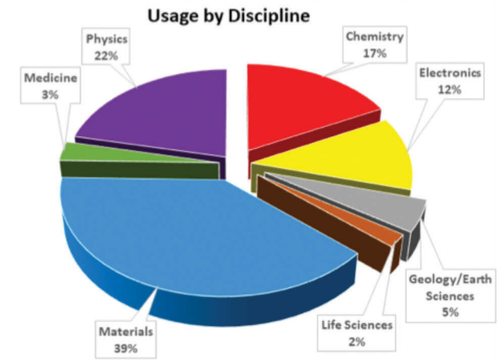
General goals of the NNF are to: (a) be an internationally recognized center of excellence for nanoscience and nanotechnology, (b) assist the NNCI in strengthening the quality and quantity of research and applications of nanoscience, nanotechnology and materials in the United States, (c) engage new university and industry users in our region in fabrication and characterization of nanoscale materials and structures, (d) provide critical assistance to companies and start-ups in order to benefit commercialization of nanotechnology, and (e) stimulate more students, including under-represented groups, to enter engineering and science careers.

The NNF provides open and affordable access to state-of-the-art facilities, expertise, training and services in nanoscience, nanotechnology, materials science and engineering to users from academia, industries and government labs. The Central and Shared Laboratory Facilities associated with NNF include: Nanofabrication Cleanroom, Nanomaterials and Thin Films, Nanoengineered Materials and Structures, Electron Nanoscopy Instrumentation, X-ray Structural Characterization, Surface and Materials Characterization, Cryogenics Instrumentation, Low-Dimensional Nanostructure Synthesis, and Laser Nanofabrication and Characterization. These NNF and NCMN Central Facilities reinforce UNL's ongoing nanoresearch programs and centers, including the NSF-funded *Materials Research Science and Engineering Center*; the *Center for Nanoferroic Devices*, funded by the Semiconductor Research Corporation and the National Institute of Standards and Technology; the NSF-funded *Center for Nanohybrid Materials*; and others. These programs emphasize education in nanoscale materials for magnetic and information technologies, electronics and sensors, energy systems and sustainable manufacturing. Important faculty and staff members in the operation of NNF include **Christian Binek** (Associate Director), **Jacob John** (NNF Coordinator), **Terese Janovec** (Education-Outreach Coordinator), **Shelli Krupicka** (Administrative Coordinator), **Patricia Fleek** (Business Manager), and **Andrei Sokolov**, **Anand Sarella**, **Steve Michalski** (M.S. 1997, Ph.D. 2007), **Jiong Hua**, **Shah Valloppilly**, **Lanping Yue**, and **Jim Li** (Research Technologists and Specialists).



The NNF technical staff has been busy growing the user base in both external university and company visitors. This has included 20 external companies and 16 external universities. Many of these were from the Midwest but also from both coasts. In the second year of operation the total number of unique users was 352, including 316 internal users and 36 external users. The total number of user hours was 20,102 including 19,275 internal and 827 external hours. The average monthly users was 120. The pie charts below show the user distributions by institution type and by discipline.

NNF's Education and Outreach Program is strong and diverse. Some examples include: (a) A traveling nanoscience exhibit seen at 7 Nebraska museums by 50,000 people; (b) Workshops to introduce NNF to industry and university scientists and engineers (100 participants); (c) A minicourse for new users (3 days, 20 participants); (d) Advanced classes focused on specific instruments, e.g., electron microscopy for 25 students; (e) Research experiences for undergraduates (REU), a 10-week summer program for 7 visiting students and 4 professors; (f) High-school intern program involving 15 students for 10 weeks in research labs; (g) K-12 Diversity programs including after-school and summer programs for 150 6-8 graders in Title I schools, and teacher conference workshops at 15 schools; and (h) College Prep Academy Program, a 2-day Nanocamp for first-generation, college-bound high school students (65 students). In addition, NNF has joined 4 other NNCI Sites in an NSF proposal for a national research experiences for teachers (RET) program. Several of the faculty and staff of NNF are on national NNCI committees including workforce development, metrics, nanofabrication and others.



NNF and NCMN had a joint review by their external advisory groups in April 2017. Among key findings were that these two centers were highly successful in reaching their goals, and that the equipment in the NNF approaches that of the best research universities. Most noteworthy is the finding that in the area of magnetic materials, the UNL group is among the top ones in the world.

In summary, NNF and the associated NCMN provide an outstanding basis for one of the strongest research and education areas at UNL, and one that is prepared for further advancement.

DEPARTMENT NEWS

New Faculty Profiles

Frank Golf

Frank Golf joined the high-energy physics (HEP) group as an Assistant Professor in August 2017. He obtained his B.S. degree in 2003 from the University of Notre Dame with dual majors in physics and mathematics. He obtained his Ph.D. in physics in 2011 from the University of California, San Diego, where he worked with Avi Yagil in searches for supersymmetry in the very first data recorded at the Large Hadron Collider (LHC). Before joining UNL, Golf was a postdoctoral researcher at the University of California, Santa Barbara, where he worked with Claudio Campagnari and others on the Compact Muon Solenoid (CMS) experiment at the LHC.

The HEP group at UNL has already established a strong position on the CMS experiment at the LHC through its work on the construction of silicon-based particle detectors, on the development of cutting edge data analysis and related software, and on the operation of computing facilities for the experiment. But perhaps no one is better prepared to take the CMS effort to an even higher level than Frank Golf, who has emerged as one of the world's experts on searches for supersymmetric particles. During his five years at UCSB, Golf completed multiple searches for SUSY particles, held multiple leadership positions within the CMS collaboration's organization that coordinates such searches, and supervised multiple graduate and undergraduate students in physics research. This has allowed him to develop expertise in both the scientific and technical aspects of searches for new particles, preparing him to continue to play a leading role in the experiment. Golf also has experience developing and constructing data acquisition instrumentation for the CMS muon detectors.

Particle physics at the LHC is as exciting as ever. The discovery of the Higgs boson in 2012 has opened a new window into the origin of mass, and the large datasets collected at the highest collision energy ever achieved in the laboratory have provided an unprecedented opportunity to search for new particles and interactions while also making precise measurements of the properties of known particles. Meanwhile, CERN, the European particle physics laboratory that is home to the LHC, is planning ambitious upgrades to the accelerator, which will come online in 2026. The High Luminosity (HL)-LHC will increase the beam intensity by more than a factor of two. This will increase the LHC dataset by a factor of fifty over its current size, which will challenge the capabilities of the detectors that record the data.

Golf is continuing his work on searches for new particles and is taking charge of UNL's effort to design and build elements of the upgraded silicon detector to be deployed for the HL-LHC. To that end, he spent the Fall 2017 semester at CERN learning the ropes of the current version of the detector, which was partially built at UNL. Golf also plans to develop new pattern recognition algorithms (to analyze the data from this detector) that can be deployed on high-performance computer processors. In addition, Golf is interested in outreach activities to students from rural areas of Nebraska who might be the first in their family to attend college.

Golf says, "The LHC is transitioning to an era of precision measurements. The high rate of proton-proton collisions that will enable this requires the development of advanced detector technologies and computing tools. I am excited to begin as a new faculty member at UNL where I hope to build on the UNL's historically strong track record of expertise in silicon detectors and in high-performance computing to advance our understanding of fundamental particles and their interactions."

Rebecca Harbison

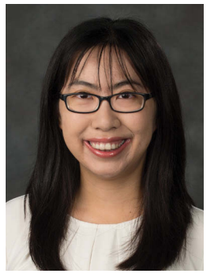
By Brad Shadwick

In 2016 alumna Rebecca A. Harbison (B.S. 2005 with High Honors) joined the Department as an Assistant Professor of Practice. Following her undergraduate degree in physics (astronomy track) at UNL, she earned M.S. and Ph.D. degrees in Astronomy at Cornell University in Ithaca, NY. Her doctoral research centered on space-craft based observations of particles in Saturn's main rings. Following her graduation from Cornell, Harbison was a Lecturer in the Department of Physics and Astronomy at the California Polytechnic State University in San Luis Obispo, CA. There she was the teacher of record for general education physics and astronomy courses, as well as introductory algebra-based and calculus-based physics courses.

Harbison's teaching activities here focus on our core undergraduate astronomy courses, ASTR 204 and 214, as well as the 400-level astronomy courses. Harbison is our first Professor of Practice. This position was created to allow the Department to offer upper-division astronomy courses on a more frequent basis than had been possible since the retirement of our last astronomy faculty member. A significant part of Harbison's responsibilities is to modernize our astronomy offerings and to provide astronomy research opportunities for our undergraduates. To this end, Harbison has established a research program that is currently analyzing data from the Cassini spacecraft. Harbison is also involved in various astronomy outreach activities.

DEPARTMENT NEWS

Peisi Huang



Peisi Huang joined the high-energy physics (HEP) group in August 2017 as an Assistant Professor and the leader of a renewed effort in theoretical particle physics. The HEP group has been lacking a theory component since the retirements of Professors **William B. Campbell** in 2004 and **C. Edward Jones** in 2007. Theoretical particle physics is currently an exciting, dynamic area of physics, challenged by the experimental facts of dark matter, dark energy, the dominance of matter over antimatter, and by the absence of new phenomena at the Large Hadron Collider beyond the Higgs boson.

Huang is a native of China who completed a Bachelor of Engineering degree at Tsinghua University, Beijing, in 2008, where she received the Outstanding Thesis Award. She then moved into the study of physics in graduate school at the University of Wisconsin-Madison. After a period of work on the ATLAS experiment at the LHC under Sau-Lan Wu, she turned towards theory, working with Vernon Barger. At Wisconsin she was the winner of an Elizabeth Hirschfelder Award and the recipient of a fellowship from the National Science Foundation as part of their support for the LHC Theory Initiative, a program to help the U.S. develop young theoretical physicists in anticipation of the start of the LHC. Huang completed her thesis on "Natural Supersymmetry and the Higgs Boson" in 2013, and then started a postdoctoral research position with Carlos Wagner, jointly sponsored by The University of Chicago and Argonne National Laboratory. In 2016 she moved to Texas A&M University to work with Bashkar Dutta before joining UNL.

Huang has diverse interests in theoretical particle physics with an emphasis in phenomenology, which she uses to explore physics beyond the standard model by interpreting measurements from the LHC and searches for dark matter. Most of her work has involved the theory of supersymmetry, but she is also interested in Higgs physics and its connection to the electroweak phase transition as well as in particle cosmology. She has begun to assemble a group of students and postdocs to (re)interpret LHC results, enable indirect searches for new physics, and establish connections between LHC physics and cosmology.

Huang is enthusiastic about joining the Department of Physics and Astronomy right now. She says, "It is the best time to be a physicist. The LHC is pushing the energy frontier and LIGO just opened a new era for cosmology. I am looking forward to exploring these exciting new developments at UNL!"

Michael Sibbernsen

By Brad Shadwick

In 2014 Michael Sibbernsen joined the Department as a Lecturer in astronomy. Sibbernsen, a dedicated astronomer, earned a B.S. in Physics from the University of Nebraska at Kearney followed by an M.S. in Teaching Physics from the University of Wyoming. Prior to joining our Department, Sibbernsen was the Science and Technology Coordinator at the Strategic Air Command & Aerospace Museum in Ashland, NE. Sibbernsen primarily teaches our large-enrollment, introductory astronomy course, ASTR 103. In the Spring 2018 semester, Sibbernsen began teaching the inaugural offering of ASTR 203, "Introduction to Observational Astronomy," which he developed. It builds on our introductory ASTR 103 course and provides hands-on experience with observational astronomy, making use of both the UNL Student Observatory in Lincoln and the Behlen Observatory near Mead, NE.

In addition to his teaching duties, Sibbernsen has taken over organization of our open house nights at Behlen Observatory. Sibbernsen is the CEO and driving force behind the recently established Branched Oak Observatory, an astronomical park located 20 miles from Lincoln. Sibbernsen is also the Special Projects Facilitator for the NASA Nebraska Space Grant and is a NASA Solar System Ambassador. Through the NASA Nebraska Space Grant, Sibbernsen operates a high-altitude ballooning program.

Recently, Sibbernsen's contributions to science education in Nebraska were recognized with awards. In September 2017, the Nebraska Association of Teachers of Science awarded him their "Catalyst Award," the organization's highest honor in recognition of significant contributions to science and science education in Nebraska. In February of 2018, he received the "Friend of Science Award" from the Nebraska Academy of Sciences for his extensive education outreach and promotion of science throughout the state.

Gay Elected Speaker of the APS Council

Amanda Lager


Timothy J. Gay

Willa Cather Professor **Timothy J. Gay** was selected in 2016 as Speaker by the Council of Representatives of the American Physical Society (APS). Gay served as Speaker-Elect in 2017 and commenced his duties as Speaker in 2018.

The Speaker of the Council presides over the Council of Representatives, comprised of national and international APS members as well as representatives of APS Divisions, Forums, and Sections. The Speaker also serves on the Board of Directors and on the Board Executive Committee.

"It's an honor to be elected to this leadership position in the APS," said Gay. "The American Physical Society represents the interests of … physicists to both the Federal government and to government funding agencies in the U.S. We also 'get the word out' to the public regarding the latest discoveries in physics, publish the most prestigious family of physics journals in the world, and run the meetings that essentially define the state of physics in the U.S. This an exciting personal and professional opportunity for me."

Prior to this role, Gay was elected to the APS Council in 2015 by the members of the APS Division of Atomic, Molecular, and Optical Physics (DAMOP), during which time he also represented the Division of Quantum Information and the Topical Group on Precision Measurement & Fundamental Constants. Councilors then chose Gay to serve on the APS Board of Directors in his first year on the Council.

The mission of the APS is to advance and diffuse the knowledge of physics through its outstanding research journals, scientific meetings, and education, outreach, advocacy, and international activities. The 53,000 members of the APS include physicists in academia, national laboratories, and industry, both in the United States and throughout the world.

Website Shows Wonders of Funsize Physics

*Editor's Note: In January 2015, Professor **Shireen Adenwalla** attended a workshop for principal investigators (PIs) funded by the National Science Foundation (NSF) that was focused on outreach. The workshop participants cohered around the idea of an outreach website and Adenwalla was asked to co-lead its development. The content – "posts" – of the website Funsize Physics come directly from researchers. For example, NSF PIs whose work is highlighted on NSF's website are often invited to submit posts of their work to Funsize Physics. Below is a slightly edited Nebraska Today article by Scott Schrage that was published on September 7, 2017. For actual Funsize Physics posts, see its web page: https://funsizephysics.com/*

NOTE: Funsize Physics is not responsible for any minds that are blown.

That tongue-in-cheek waiver, which immediately greets visitors to the website *Funsize Physics*, fittingly manages to capture both its spirit and mission in one short sentence. Launched by UNL with support from the National Science Foundation, the website features brief highlights of condensed-matter physics research and classroom activities written by NSF-funded researchers from across the United States.

Condensed-matter physics concerns the cooperative behavior of atoms or molecules, which may enable strange and exotic phenomena to emerge. For instance, the interactions that can turn a liquid into the "anti-molasses" form of matter known as a superfluid. Or the atomic structure of a material that allows an inkjet printer to churn out solar cells. Or the assembly of carbon-based "onions" small enough to ferry therapeutic drugs through a bloodstream. Those phenomena, and many others, get their due on Funsize Physics in the form of easy-to-read posts that favor approachability over technicality.

"When you get atoms and molecules together, all this weird stuff starts to happen," said **Jocelyn Bosley**, the site's curator and assistant director for education and outreach at the Nebraska Materials Research Science and Engineering Center. "That's what I think is really cool – all of these weird effects that happen when you get them interacting really closely like that."

"People haven't heard of (the field) as much, because I think maybe it's not as sexy as astronomy or high-energy physics," said Professor **Shireen Adenwalla**, who conceived the website. "But condensed-matter physics is very beautiful. I don't think people know that, and I think it's true that condensed-matter physics has been disregarded. So, we decided we wanted to start a website, and we wanted many people to contribute."

The website, which went live in 2016, recently received another round of funding from the National Science Foundation. Since the launch, researchers at more than 20 institutions – ranging from the University of Southern California and Ohio State University to North Carolina State University and the University of Pittsburgh – have contributed. Most have come directly from the field of condensed-matter physics, though Adenwalla welcomes anyone funded by the NSF's Division of Materials Research – chemists, engineers, biologists – to submit entries. Department faculty who have contributed posts include Shireen Adenwalla, **Peter Dowben**, **Axel Enders**, **Xia Hong**, **Alexey Kovalev**, and **Xiaoshan Xu**.

"We feel like this is very important, because I think we're not good at trumpeting what we do," Adenwalla said. "I don't mean in the sense of showing off; I mean in the sense of letting people know what we're doing. This is public money: your taxes, my taxes. How do we let you know not only that it's beautiful science, but (also that) it leads to wonderful things?"

To reach that goal, Adenwalla and Bosley first had to answer one of the most fundamental but often daunting questions facing any communicator: Who's the audience? Knowing that they wanted to reach anyone without a physics background but with an interest in the field, the pair initially gave little guidance on how much breadth or depth the submissions should encompass. But after receiving a wide range of submissions – everything from dense, lengthy write-ups to equations with little text explaining them – Adenwalla and Bosley reconsidered their approach.

"If you just tell the contributors to write for a general audience, they have no idea what that audience knows or doesn't know," said Bosley. "And it's fair enough, because that's so vague. But when we told them, 'Write it so that a bright, interested middle-schooler could understand most of it,' then they would go, 'Oh! OK.' It's not that those are the only people we want to reach, but there's a lot of stuff that kids in middle school learn that adults have forgotten, so I don't think you're missing the mark too widely with the general public if you go with that."

Adenwalla and Bosley also had to decide which aspects of the research to highlight. The fact that condensed-matter physics has spawned countless technologies – and continues to drive innovation across virtually every industry – makes a compelling case for covering its applications, which the site does. "Condensed-matter physics is what gave us transistors. And without silicon transistors, what would you be carrying around?" Adenwalla asked. "You'd be carrying around a chest, not a laptop or an iPad or an iPhone." Yet concentrating solely on applications, Adenwalla said, risks diminishing the sense of awe that first attracted her – and many researchers – to the field. So, the website liberally incorporates metaphor, historical context, imagery and video to help stimulate the curiosity of someone who's never encountered the term "skyrmion" or "spintronics" or "quantum vortices."

"Sometimes there's this dynamic where people are trying to justify (the research) in terms of practical benefits, and then people feed into that by deciding whether they think that's sufficient or not," Bosley said. "It just makes the whole dialogue about that, when that might be part of it, but there's more to it than that." Though Adenwalla described herself as "not very good" at explaining physics to lay audiences, she conceded that she has improved since undertaking the Funsize Physics project. And that, said Bosley, represents the website's other primary objective.

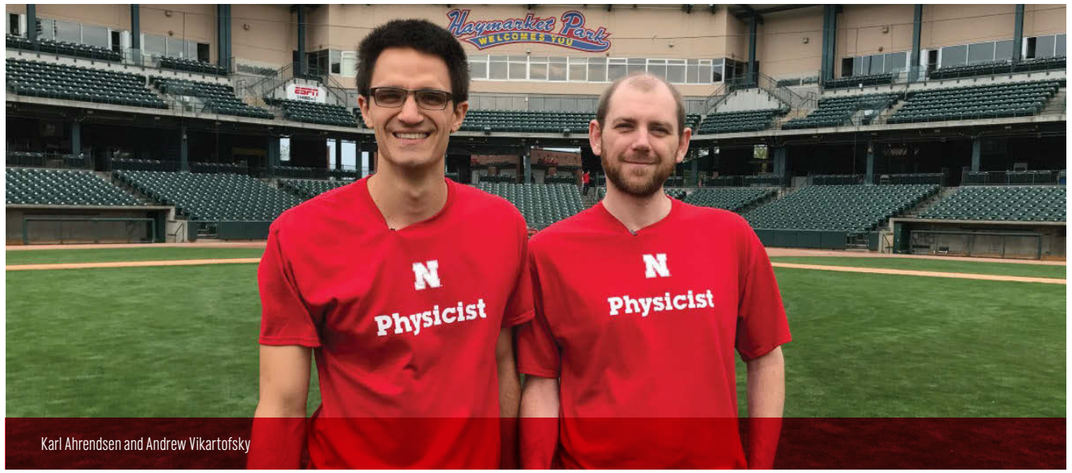
"I think there was a sense (among some contributors) – much like the sense people have about other skills, like writing and speaking – that you're just innately good at it or not," Bosley said. "And if you're not, then you're off the hook. You don't have to try to do it. So, I think that was a problem. We want to encourage them to think, 'Just because I don't know how to do this doesn't mean I can't learn how to do it.' I think that what excites physicists about their work, and what excites the public about their work, is not so different. It's just a matter of (surmounting) the communication barrier between them."

Crafting a post that balances information with brevity, nuance with comprehension and accuracy with readability can test even the most conscientious writer, Adenwalla said. But the site's contributors have reported learning a lot that they plan to apply going forward, she said, and most have found it more charm than chore. "I do think, overwhelmingly, that they are surprised by how painless and even fun the process is," Bosley said. "They actually have a good time and get into it. People don't (always) realize that they actually get something out of it, too, until they go through the process. Then they're like, 'Hey, I liked that. That was actually fun for me, too.'"

"It's not like, 'Eat your kale! You'd better do it!'" Adenwalla said. "We want to facilitate the urge that I think many people have: to tell people what science they're doing. Everyone likes to talk about what they do, what they're passionate about. Hopefully this encourages it."

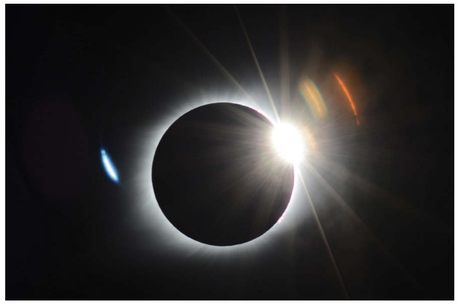
Jocelyn Bosley (left) and Shireen Adenwalla

In the Path of Totality: The 21 August 2017 Eclipse



Karl Ahrendsen and Andrew Vikartofsky

More than 200 communities across Nebraska, including Lincoln, were in the path of totality (in the shadow of the Moon) during the solar eclipse that took place on Monday, 21 August (the first day of classes of the Fall 2017 semester). This was the first total solar eclipse viewable within the U.S. since February 26, 1979, and the first since 1918 to cross the entire continental U.S. from coast to coast. The Department, UNL, and cities across the state were active in promoting and supporting the once-in-a-lifetime event. Visitors descended on the state from around the world and hotel rooms were fully booked months in advance. Totality in Lincoln started at 1:02 p.m. and lasted 84 seconds. Although cloud cover had grown significantly by late morning, the clouds parted just in time to see the diamond ring effect that occurred as the sun entered totality. As the city went dark-as-night and street lights started to flicker on, cheers erupted across the city.



Professor **Stephen Ducharme** first proposed that the Department take the lead in organizing a public education event to capitalize on the eclipse in Spring 2015. Professor and Department Chair **Daniel Claes** found interest among the Department of Earth and Atmospheric Sciences, the NU Foundation, University Communications, and the College of Arts & Sciences Office of Marketing and Communication. He officially convened the first meeting of this group on 22 Sept 2015. They met bimonthly for a year, and then monthly. Traffic logistics and crowd control for the first day of classes, as well as liability issues, were eventually cited in denying this group the ability to organize anything other than student activities on campus. With plans falling through for a Memorial Stadium public gathering, Claes met with the city of Lincoln's Convention and Visitors Bureau director, the Chamber of Commerce, and the Lincoln Salt Dogs organization about the use of Haymarket Park. The Saltdogs, members of the American Association of Independent Professional Baseball's Northern League, were instantly excited about hosting a day game that Monday. They quickly filed a request and within a month it made the league's schedule. Planning then began for a special "Eclipse-Delayed" Game together with a University-sponsored Science and Engineering Expo Fair. Claes continued working with the Convention and Visitors Bureau, assembling and promoting an entire weekend of activities: special shows at UNL's planetarium, public events at Behlen Observatory, Holmes Lake, and the student observatory atop Memorial Stadium Garage, and a slate of popular science talks at the Lincoln Children's Museum.

Starting in March, Claes began meeting with a Student Affairs Committee (comprised of personnel from Campus Rec, Greek Affairs, Housing, Student Involvement, and the Office of Academic Success) interested in assisting in activities for all UNL students staying on campus that day. They arranged for University-wide promotion of the events through messaging across all University home-pages, with tie-ins to the parents' weekend and new student orientation events just prior to the start of classes and the eclipse. They also secured ISO-certified eclipse-viewing glasses in sufficient number to provide safe viewing to every UNL student, staff and faculty member, and developed logistics for efficiently distributing the glasses.

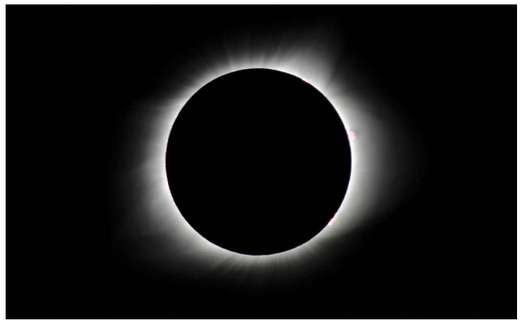
Prior to the eclipse, Claes recruited two of our graduate students, **Karl Ahrendsen** and **Andrew Vikartofsky**, to work with UNL videographers to create four eclipse-related outreach videos. These amusing videos dealt with the rarity of a total solar eclipse [https://youtu.be/zqUm2R6zETA], the path of totality across the U.S.A. [https://youtu.be/adq4xnqaXEw], the reason the small Moon can completely block the light from the huge Sun [https://youtu.be/4tsf3U0tN6A], and the necessity for wearing safety glasses [https://youtu.be/RLzL-eRmSlc]. The videos were posted on the UNL Web page and on YouTube. They helped generate interest and prepared viewers for the actual event.

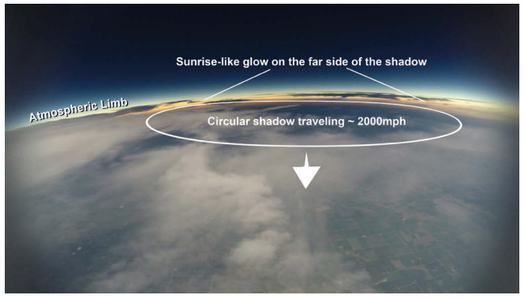

Professor Stephen Ducharme (left) and Sunspotter telescopes.

On the day of the eclipse, Professors Daniel Claes and **Timothy Gay** together with University of Arizona Professor Richard Green, former Director of Kitt Peak National Observatory, provided live coverage of the event. This coverage took place at the Department's student observatory on top of the Stadium Drive parking garage and was carried by the Big Ten Network Online Channel from 11:30 a.m. (the time the eclipse began) - 1:30 p.m. (about 26 minutes after total eclipse ended). It logged 6,113 unique viewers from around the world as well as unknown numbers of others via re-broadcasts by local cable channels, NASA, and NPR stations!

Simultaneously, a few thousand attendees joined Department faculty and students (as well as exhibitors from other UNL science and engineering departments) at the Lincoln Haymarket Park for a STEM Expo. Although 6,956 fans watched the Saltdogs defeat the Gary Southshore Railcats 8-5, most came (from as far away as the United Kingdom) for the eclipse. Busloads of students from towns across Nebraska attended the Expo and stayed for the game. The Expo began at 10 a.m. outside the stadium gates (making it freely available to the public) and the gates opened at 11 a.m. for ticket holders. The Department brought four Sunspotter solar telescopes through which attendees could safely watch the progression of the Moon's path across the Sun. The Society of Physics Students also brought several demonstrations on electric charge, inertia, and the orbits of the Moon and the Earth around the Sun. Undergraduate astronomy teaching assistant **Zachary Smith** manned a telescope outfitted with a filter designed to block out the majority of the Sun's light so that viewers could examine sunspots and other solar phenomena. The Department partnered with the Lincoln Saltdogs professional baseball team to halt their scheduled game for the 30 minutes leading up to and through the 84 seconds of totality, so fans could attend the Expo and fully enjoy the experience.

Meanwhile, in Grand Island, NE, Astronomy Lecturer **Michael Sibbernsen** and his wife, **Kendra (Stahl) Sibbernsen** (M.S. 1995) led the NASA Nebraska High Altitude Ballooning Project, one of 55 ballooning teams from across the nation supported by NASA's Science Mission Directorate and the NASA Nebraska Space Grant. Sibbernsen's team launched three balloons from the Stuhr Museum in Grand Island. According to Sibbernsen, all three balloons were launched on time, were in the air during totality, and all the payloads were recovered. The balloons carried tracking devices,





Balloon launch from Stuhr Museum.

remote sensors, and cameras that collected environmental data and photographs while streaming live video of the eclipse path directly to the internet. The research payloads included student-developed experiments and a NASA Ames astrobiology project studying the survivability of bacteria at different altitudes.

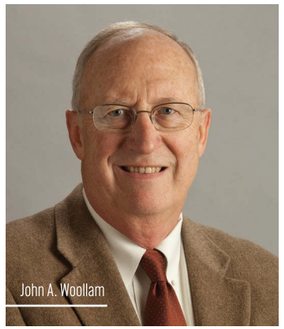
The highest balloon reached over 109,000 ft. and, although there were a few technical difficulties with some of the student experiments, the project overall was deemed a great success. For more on the NASA Nebraska Solar Eclipse Balloon Project, including photos and videos, go to: www.nearspacescience.com/total-solar-eclipse-82117/

DEPARTMENT NEWS

Saturday Science Program Renamed and Endowed

As reported in the last issue of Spectrum, our Saturday Science program for elementary school students has been going strong since it was started by Professor **Duane Jaecks** in 1975. It is currently directed by Research Professor **Cliff Bettis** and serves a total of 160 5th-grade public school students (80 students in each morning and afternoon session) on four Saturdays each February. Lincoln Public School (LPS) administrators advertise Saturday Science and accept applications on a first-come, first-served basis. There is a $40 tuition fee, which LPS collects. The program is always oversubscribed. At a ceremony in February 2017, the program was renamed after its founder: it is now the *Duane Jaecks Saturday Science* program.

In order to ensure the continued success of Saturday Science, in 2015 George Holmes Distinguished Professor of Electrical Engineering, **John A. Woollam**, committed up to $40,000 to the Foundation for LPS as a challenge grant to support Saturday Science. The challenge specified that if matched by 31 March 2016, the LPS Foundation would have an $80,000 endowment, the income from which would support the continued development of our Saturday Science Program. The expenses of the program include scholarships for students whose families are unable to pay the tuition fee, stipends for the graduate students who supervise the laboratory part of the program, and supplies for the laboratory experiments the students carry out (and for the scientific devices that they build in Department labs and take home). Woollam built the J. A. Woollam Company in Lincoln, which is one of the world's most successful manufacturers of ellipsometers. In 2013 Woollam won the American Physical Society's Prize for Industrial Applications of Physics. Most recently, he has been inducted into the National Academy of Inventors.


John A. Woollam

In mid-March 2016, the Foundation for LPS informed the Department that the $80,000 endowment challenge has been achieved! In addition to contributions from various Department faculty, including a significant lead gift from Duane Jaecks, a large gift was provided by Chuck and Barbara Francis. Chuck Francis is Professor of Agronomy and Horticulture at UNL and Barbara is a Spanish teacher at Lincoln's Montessori School for Young Children. The Foundation for LPS approached Chuck and Barbara with the idea for contributing to Woollam's challenge grant because "they are absolutely conscientious, selfless people who care a great deal about education and experiences which contribute to the common good and to bettering the human condition."

"Saturday Science has been a wonderful partnership between the UNL Physics Department and Lincoln Public Schools for decades," says Bettis. "Its primary mission has been to supplement young children's science education, but it has had a wider impact. Many of our graduate teaching assistants go on to help with science fairs because of the connections they make at Saturday Science. We have student interns in our department's summer program who came to us through Saturday Science connections."


Duane Jaecks at February 2017 renaming ceremony.

RESEARCH HIGHLIGHTS

Study Confirms Cosmic Rays Have Extragalactic Origins

*Editor's Note: An article entitled "Observation of a large-scale anisotropy in the arrival directions of cosmic rays above 8 x 10^{18} eV" by The Pierre Auger Collaboration [Science **357**, 1266 (2017)] reported an anisotropy in the arrival directions of very high energy cosmic rays recorded at the Pierre Auger Observatory in Malargüe, Argentina. That anisotropy indicated an extragalactic origin of these most energetic cosmic rays. Professor **Gregory Snow** is a member of the Collaboration. He has explained the significance of these results in a video (https://mediahub.unl.edu/media/8447). Below is a slightly edited UNL Nebraska Today story written by Leslie Reed that was published on September 21, 2017.*

For the first time, scientists have confirmed that the highest-energy cosmic rays that bombard the Earth come from outside the Milky Way galaxy. In an article published in the journal Science, a group of more than 400 scientists from 18 nations describe how they detected an anisotropy, an asymmetry in the cosmic particles' distribution of arrival directions as they approach Earth. The prominent arrival direction is from a broad area of the sky about 120 degrees away from the direction that points to the center of our Milky Way galaxy, where some scientists have hypothesized the rays may originate. "There have been other pieces of evidence, but I would say this paper really confirms that most of the highest-energy cosmic ray particles are not coming from the Milky Way galaxy," said Professor **Gregory Snow**, who is education and outreach coordinator for the Pierre Auger Observatory project.

The new results are based on 12 years of data collection by the Pierre Auger Observatory, built in the plains of western Argentina in 2001 specifically to learn more about cosmic rays and where they come from. The observatory collects data from 1,600 particle detectors deployed in a hexagonal grid over 1,160 square miles – an area larger than Rhode Island. A set of telescopes also is used to observe the faint fluorescent light that the charged particles emit at night. Snow says cosmic rays are clues to the very structure of the universe. "By understanding the origins of these particles, we hope to understand more about the origin of the universe, the Big Bang, how galaxies and black holes formed and things like that," he said. "These are some of the most important questions in astrophysics."

As the Science article explains, ultrahigh-energy cosmic rays have been observed for more than 50 years, but their sources remain a mystery. The best hope of finding their origins is to study their directions of travel as they approach Earth – but that is surprisingly difficult. Because they are charged particles, they interact with the magnetic fields of the Milky Way and beyond. The intergalactic magnetic fields deflect the cosmic ray particles by a small amount from their directions of origin. The task is even more challenging because the highest-energy particles – those with energies reaching quintillions of electron volts – reach Earth at a rate of only one particle per square kilometer each year.

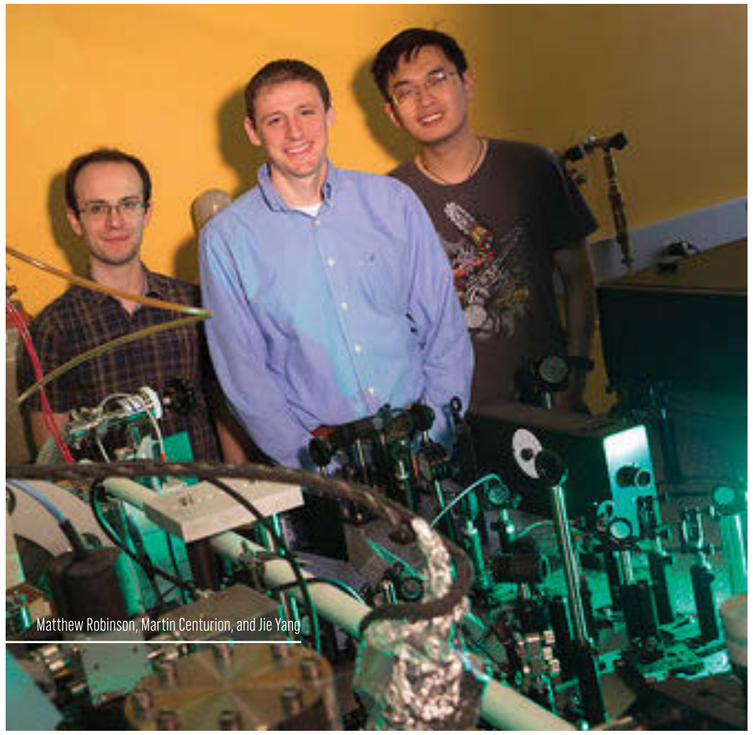
"The sun emits low-energy cosmic ray particles that are detected here on Earth, but they are nowhere near as high energy as the particles detected at the Auger Observatory," Snow said. "The particles we detect are so energetic they have to come from astrophysical phenomena that are extremely violent. Some galaxies have an explosive, massive black hole in their centers and there are theories that these very violent centers accelerate particles of very high energy that eventually reach Earth."

The Auger Observatory was created under the leadership of James Cronin, a Nobel Prize-winning physicist from the University of Chicago who died in 2016, and Alan Watson from the University of Leeds in the United Kingdom.

Although Snow is the only professor at Nebraska who is part of the Pierre Auger collaboration, he and Nebraska physics department chair **Daniel R. Claes** have a special interest in cosmic rays. In 2000, they started to deploy cosmic ray detectors throughout the state for the Cosmic Ray Observatory Project. The National Science Foundation-funded effort enlists high school students and their teachers to collect research-quality data on cosmic rays. The project uses equipment donated by Cronin after he completed a previous cosmic ray research project. It was that relationship that led Cronin to invite Snow to join the Auger Observatory, Snow said.


Gregory Snow

Physicists Record Movement of Atomic Nuclei



Matthew Robinson, Martin Centurion, and Jie Yang

*Editor's Note: In a Letter entitled "Diffractive Imaging of Coherent Nuclear Motion in Isolated Molecules" [Physical Review Letters 117, 153002 (2016)], a large collaboration of scientists led by Associate Professor **Martin Centurion's** group reported the observation of the vibrational motion of isolated iodine molecules by diffracting ultrashort pulses of relativistic electrons from the molecules. The Editor's Suggestion Letter was the subject of a Physics Viewpoint article by Marc Vrakking, "Showtime for Molecular Movies": https://physics.aps.org/articles/v9/112*

A movie of the vibrational motion may be viewed in the SLAC National Accelerator Laboratory press release: https://www6.slac.stanford.edu/news/2016-08-31-slac-high-speed-electron-camera-films-atomic-nuclei-vibrating-molecules.aspx Below is a slightly edited UNL Nebraska Today story written by Scott Schrage that was published on September 27, 2016.

Physicists from UNL, the SLAC National Accelerator Laboratory, and Potsdam University are picking up good vibrations – via laser-driven excitations – after successfully recording the spring-like motion of a two-atom molecule. As reported in the journal Physical Review Letters, the researchers, led by **Martin Centurion**, Rosowski Associate Professor of Physics, captured the continuous motion of atomic nuclei in vibrating molecules for the first time.

Recording this nuclear motion represents a milestone in the quest to produce "molecular movies" that could eventually unveil the dynamics of light-triggered chemical reactions.

"The main thing we want to see is when the molecular structure is changing," said co-author Martin Centurion,… "That we had not yet demonstrated (until now)." Though molecules are always vibrating, light can excite their atoms into different structural configurations that result in photochemical reactions. While photosynthesis is considered the classic example, many other reactions regularly serve to help and harm – as when forming protective ozone in the Earth's atmosphere, for instance, or the ultraviolet rays that cause skin cancer.

The researchers induced similar excitations by firing a laser at molecules consisting of two iodine atoms, which share a weak bond that alternately elongates and compresses like a spring when the atoms absorb light. That same laser, which resides at the Stanford University-housed SLAC lab, also triggered a short burst of electrons that raced toward the molecules at nearly the speed of light. After measuring how the electrons diffracted from the laser-excited molecules – and comparing the patterns with those created when electrons struck undisturbed molecules – the researchers managed to calculate sequential positions of the molecules' atoms. Those positions are essentially akin to frames that form a motion picture when stitched together, Centurion said.

Catching some waves

Similar to light, electrons exhibit properties of both particles and waves. The wavelike nature of light was famously demonstrated through the so-called double-slit experiment, in which a laser passing through two small openings produced not two points of light but instead an alternating pattern of bright and dark bands reminiscent of overlapping ripples in a pond. That experiment also showed that the distance between the slits dictated the interference pattern: closing the distance widened the dark gaps between the bands of light, whereas expanding that distance narrowed them. Because Centurion and his colleagues were firing electrons at many molecules oriented in various directions, their own interference patterns took the form of rings rather than straight bands. But just as in the classic double-slit experiment, the patterns of those rings changed in tandem with the distance between the iodine atoms. That distance fluctuated by about 50 percent, which Centurion described as a "pretty big" amount. Yet the time it takes is anything but: An iodine molecule cycles through one springing motion in about 400 femtoseconds, which compares to one second as one second compares to roughly 80,000 years. The researchers chose to work with a two-iodine molecule partly because physicists are familiar with its dynamics, making it a fitting test subject. "We knew exactly how we should hit it to get this vibration," Centurion said. "In a sense, we're still trying to take a known system and test our apparatus with that system."

The great unknown

Centurion said he and his colleagues are also setting their sights on less familiar, and more complex, molecular reactions. Those efforts will include trying to capture how nuclei respond when lasers of sufficient energy actually break atomic bonds, rather than simply distort them. "Basically, we want to now go to a case where what happens is unknown," he said. "We now have an instrument with which we hope to be doing some new science."

The staggering complexity of photochemical reactions in molecules featuring even a few atoms, Centurion said, makes the prospect of capturing their nuclear movements an especially appealing prospect. "If we can see these things as they're happening, then there can start to be more feedback between theory and experiment," he said. "They can feed on each other and hopefully develop something that's good enough to be somewhat predictive. And if you can really understand these reactions and predict them, then you can maybe design (a molecule) that has certain properties. You could attach it to a (therapeutic drug) or use it to help transfer solar energy from a panel to a battery. I think we're still very far from that, but that's the goal."

The Letter was authored by 20 researchers. It was a collaboration between Martin Centurion's group at UNL, researchers at SLAC National Accelerator Laboratory, and Potsdam University. The first author was UNL graduate student **Jie Yang** (Ph.D. 2016), who is now a postdoctoral researcher at SLAC. Postdoctoral research associate **Matthew S. Robinson** was also part of the UNL team; he is now a postdoctoral researcher in the group of Markus Guehr at Potsdam University. The work was funded in part by the U.S. Department of Energy's Office of Science.

In the News...

Editor's Note: Many articles about Department faculty, staff, and students have appeared on the Web. Below is a selection of recent articles that may be accessed by using the URL indicated.

"Nebraska laser lab generates light that's 'out of this world'," Big Ten Network, 16 November 2015: http://btn.com/2015/11/09/btn-livebig-nebraska-laser-lab-generates-light-thats-out-of-this-world/

"Novel X-ray method could detect nuclear materials," UNL Today, 21 December 2015: https://news.unl.edu/newsrooms/today/article/novel-x-ray-method-could-detect-nuclear-materials/

"Cover illustration features Fuchs' research," UNL Today, 8 January 2016: https://news.unl.edu/newsrooms/unltoday/article/cover-illustration-features-fuchs-research/

"Team finds unexpected magnetism in nanoscale compound," UNL Today, 15 March 2016: https://news.unl.edu/newsrooms/today/article/team-finds-unexpected-magnetism-in-nanoscale-compound/

"Physicists get surprising results from electron-molecule collisions," UNL Today, 30 March 2016: https://news.unl.edu/newsrooms/today/article/physicists-get-surprising-results-from-electron-molecule-collisions/

"Diocles Featured on 2016 Cover of Contemporary Physics," Department of Physics and Astronomy, 11 April 2016: https://www.unl.edu/physics/news/diocles-featured-2016-cover-contemporary-physics

"Study shines new light on electrons," UNL Today, 22 April 2016: https://news.unl.edu/newsrooms/unltoday/article/study-shines-new-light-on-electrons/

"Centurion's Research Highlighted by DOE Basic Energy Sciences," Department of Physics and Astronomy, 3 May 2016: https://www.unl.edu/physics/news/centurions-research-highlighted-doe-basic-energy-sciences

"Tsymbal Group Research Featured on Physical Review Letters Cover," Department of Physics and Astronomy, 13 May 2016: https://www.unl.edu/physics/news/tsymbal-group-research-featured-physical-review-letters-cover

"Hong earns Early Career Award," UNL Today, 27 May 2016: https://news.unl.edu/newsrooms/today/article/hong-earns-early-career-award/

"Discovery bolsters emerging form of digital memory," UNL Today, 24 June 2016: https://news.unl.edu/newsrooms/today/article/discovery-bolsters-emerging-form-of-digital-memory/

"Ngoko Djiokap's Research Highlighted by DOE Basic Energy Sciences," Department of Physics and Astronomy, 12 September 2016: https://www.unl.edu/physics/news/ngoko-djiokaps-research-highlighted-doe-basic-energy-sciences

"Dowben, Enders Team Experiment Headed for ISS," Department of Physics and Astronomy, 17 October 2016: https://www.unl.edu/physics/news/dowben-team-experiment-headed-iss

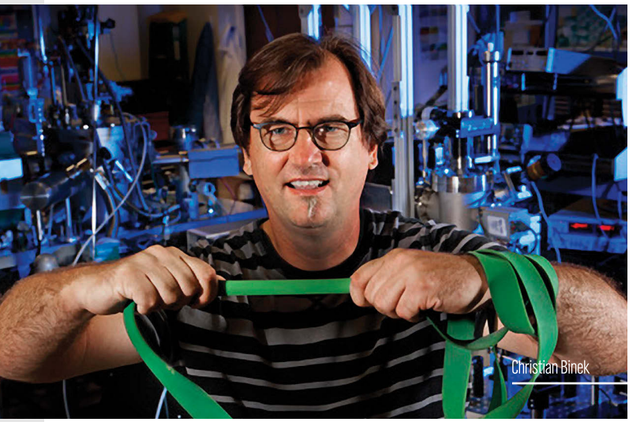
"Xi He Research Highlighted in Nature Letter," Department of Physics and Astronomy, 27 January 2017: https://www.unl.edu/physics/news/xi-he-research-highlighted-nature-letter

"Enders, Dowben, and Team Create New 2D Material," Department of Physics and Astronomy, 16 February 2017: https://www.unl.edu/physics/news/enders-dowben-and-team-create-new-2d-material

RESEARCH HIGHLIGHTS

Controlling Elasticity with Magnetism

*Editor's Note: In a paper entitled "Elastic properties of superconductors and materials with weakly correlated spins" [Scientific Reports 7, 4906 (2017)], Professor **Christian Binek** showed by means of a thermodynamic approach that one can tailor the elastic properties of a material by appropriately designing its magnetic properties. The work has been featured on the web pages of Materials Today: https://www.materialstoday.com/computation-theory/news/elasticity-controlled-by-magnetic-fields/ and phys.org: https://phys.org/news/2017-07-physicist-elasticity-magnetism.html Below is a slightly edited UNL Nebraska Today story written by Scott Schrage that was published on July 19, 2017.*


Christian Binek

Professor **Christian Binek** has found that under certain conditions, the magnetic properties of a material can predict the relationship between its elasticity and temperature. This finding may point the way toward controlling the elasticity of certain materials by designing their magnetic properties or applying a magnetic field to them. Given the ease with which magnetic fields can now be manipulated, Binek said, that could eventually mean tailoring elasticity with the mere press of a button or turn of a knob. In the meantime, knowing that in some cases magnetism alone can predict how elasticity will respond – or not respond – to changes in temperature might help engineers better select or design materials for specific purposes. Binek cited the 1986 disintegration of the Challenger space shuttle as a prominent example of elasticity's importance in engineering design. The hardening and failure of an elastic O-ring on Challenger's rocket booster – a consequence of cold temperatures – ultimately caused the shuttle to break apart, killing its seven crew members.

"So, you can find materials that do not change elastic properties with temperature," said Binek, professor of physics and astronomy. "You may find materials that change with temperature at will. And you may find materials where you can, at a given temperature, change the elastic properties by an external control."

Thermodynamic duo

The laws of thermodynamics describe the relationships among many factors – temperature, entropy, volume, pressure – that affect how heat gets converted into other forms of energy. And it's long been known that these laws encompass the properties of magnetism and elasticity. But by deriving a new formula from existing ones, Binek managed to show that the elasticity-temperature relationship is basically encoded in the magnetism of a material.

Binek's formula does have limitations. For now, it applies only if a material's magnetic behavior changes linearly with the magnetic field being applied to it. Likewise, the material's elasticity has to be linear, meaning that the amount of strain it exhibits has to be constantly proportional to the amount of physical stress being exerted on it. In addition, similar changes of the material's internal energy must occur when the same work done by straining the material is done by an applied magnetic field. Even so, the formula applies to materials featuring various forms of magnetism. That includes the form technically found in every material: diamagnetism, which describes a tendency to repel magnetic fields so weakly that it goes unnoticed without specialized instruments.

Superconductive materials – those that feature no resistance to electricity – display a pronounced form of diamagnetism below a critical temperature, at which point they begin to completely repel magnetic fields. Below that temperature threshold, Binek found something remarkable: The elasticity of superconductors no longer responds to temperature changes. That phenomenon held when he performed calculations for both ceramic and single-crystal superconductors, which have substantially different microscopic surfaces and atomic structures.

"My (mathematical) expression makes no claims about the material," Binek said. "It's very general. It only says: If the susceptibility (to magnetism) is constant, then the elastic property should be constant. If that is so, nothing else (about the superconductor) should matter, which is honestly a little difficult to believe. You wonder: How can something like an elastic property, which surely depends on structural details, be independent of anything related to the structure? But then you go to the (scientific) literature, apply your formula, and you find that, yes, it is correct."

The elastic-magnetic formula also applies to materials for which magnetic fields induce a weak attraction known as paramagnetism. And ferromagnetic materials – those strongly attracted to magnetic fields and usually synonymous with the term "magnetic" – obey Binek's formula above a certain temperature threshold that makes them behave more like their paramagnetic cousins. Binek said the formula might even work for ferroelectric materials, whose alignment of positive and negative charges, or polarization, can be reversed by an electric field. Ferroelectricity facilitates the storage of electrical energy, making it useful in devices ranging from capacitors to random-access memory. "Rather than tuning the elastic properties by a magnetic field, you may be able to tune them by electric fields," he said. "Technologically, that could be even more interesting. There are certainly many applications that one could think of, and I think many of them can be useful. I hope this is not the end of the story, but rather the beginning."

Binek conducted his research as part of the *Nebraska Materials Research Science and Engineering Center*, one of 21 MRSEC centers funded by the National Science Foundation. He is also the Associate Director of the Nebraska Nanoscale Facility, the subject of this issue's cover story.

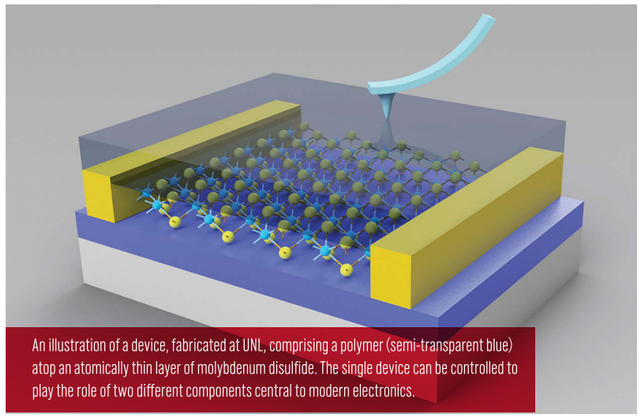
RESEARCH HIGHLIGHTS

New Approach Could Transform Semiconductor Technology

*Editor's Note: In a Letter entitled "Ferroelectric-Domain-Patterning-Controlled Schottky Junction State in Monolayer MoS_2" [Physical Review Letters **118**, 236801 (2017)], Associate Professor **Xia Hong** and colleagues reported success in fabricating layered thin-film heterostructures that can be programmed with a variety of functionalities. Below is a slightly edited UNL Nebraska Today story written by Scott Schrage that was published on June 7, 2017.*


Xia Hong

Recent research from UNL may help future engineers of digital components get two (or more) in the space of one. A team of physicists has demonstrated a reversible method for altering the electronic properties of a nanoscopic material, pointing the way toward merging several hallmark functions of modern electronics into a single component. The approach might ultimately allow a 2-D material to shift from digital processing to power conversion to light-triggered applications. That versatility, in turn, could give engineers additional options for scaling down electronics by squeezing more functionality into one device.


An illustration of a device, fabricated at UNL, comprising a polymer (semi-transparent blue) atop an atomically thin layer of molybdenum disulfide. The single device can be controlled to play the role of two different components central to modern electronics.

Associate Professor **Xia Hong** and her colleagues started with an atomically thin slice of molybdenum disulfide, or MoS_2, a chemical compound whose semiconducting properties resemble those of industry favorite silicon. They then overlaid the MoS_2 with a polymer featuring ferroelectricity – the ability to reverse the alignment of its separated positive and negative charges, or polarization, by applying an electric field to it. The researchers discovered that they could radically reconfigure the electronic behavior of the MoS_2 by selectively applying voltage across the polymer to dictate the direction of its polarization. When Hong's team aligned the polymer's positive or negative charges either toward or away from the layer of MoS_2, the latter's electric current flowed freely in both directions and corresponded to the amount of voltage applied. In that state, the MoS_2 played the role of a transistor, a signature component of digital processing that releases and suppresses electric current carrying the binary language of 1s and 0s.

But when the team polarized the polymer in a different way – creating two domains of vertically oriented but oppositely aligned polarizations – the underlying MoS_2 adopted a new identity. Rather than acting as a transistor, the MoS_2 became a diode, allowing current to flow in one direction but resisting its movement in the other when subjected to different polarities but the same amount of voltage. Among their many purposes, diodes convert the two-way flow of alternating current – used in powering homes and other structures – into the one-way transmission of direct current that powers virtually any technology containing a battery. They also reside at the heart of many light-powered and light-producing devices, from solar cells to LED displays.

The MoS_2 maintained its transistor and diode states even when the voltage was removed, Hong said. That quality, combined with the technique's low voltage requirements and nanoscopic scale, led her to describe it as "very promising" for low-power technological applications. The mechanical properties of the atom-thin MoS_2 channel and ferroelectric polymer, she said, could prove especially suited to the sort of flexible electronics found in wearable technology.

"This is not just a performance enhancement," said Hong, associate professor of physics and astronomy. "It's really (about) creating a new type of multi-functional device." Hong said the approach's reversibility might make it preferable to the decades-old semiconductor treatment process known as doping, a chemically-based technique that effectively locks a semiconductor design into one function or another. "The nice thing about this approach is that we're not changing anything chemically," Hong said. "What we're doing here is reprogramming the function electrically." Having demonstrated the new technique with a ferroelectric polymer, Hong and her colleagues are now exploring the use of compounds known as oxides, which better withstand the heat produced by many electronics.

Hong's team detailed its new technique in the journal Physical Review Letters. The UNL team included graduate student **Zhiyong Xiao**, postdoctoral research associate **Jingfeng Song**, and Professor **Stephen Ducharme**. Support was provided by the U.S. Department of Energy's Office of Science, the National Science Foundation, Nebraska's Materials Research Science and Engineering Center, one of 21 such NSF-funded centers in the United States. The authors performed part of their research at the Nebraska Nanoscale Facility, one of 16 facilities established under the NSF's National Nanotechnology Coordinated Infrastructure.

One Billion Suns: World's Brightest Laser Sparks New Behavior in Light

Editor's Note: A recent publication entitled "High-Order Multiphoton Thomson Scattering" [Nature Photonics 11, 514 (2017)] co-authored by a team comprising graduate students, postdocs, and research faculty led by Olson Professor of Physics ***Donald P. Umstadter*** *has demonstrated a novel way to convert 1.55 eV near infrared laser light to pulses of 20 MeV hard X-rays having attosecond durations. This was accomplished by scattering an intense laser beam from a laser-driven relativistic electron beam whereby more than 500 laser photons were converted and frequency up-shifted to a single hard X-ray photon. This accomplishment has been highlighted by the National Science Foundation: https://news.science360.gov/archives/20170628/ Below is a slightly edited UNL Nebraska Today story written by Scott Schrage that was published on June 26, 2017. The team's work was featured on the cover of the August 2017 issue of Nature Photonics.*

Physicists from the University of Nebraska-Lincoln are seeing an everyday phenomenon in a new light. By focusing laser light to a brightness 1 billion times greater than the surface of the sun — the brightest light ever produced on Earth — the physicists have observed changes in a vision-enabling interaction between light and matter. Those changes yielded unique X-ray pulses with the potential to generate extremely high-resolution imagery useful for medical, engineering, scientific and security purposes. The team's findings… should also help inform future experiments involving high-intensity lasers.


Donald Umstadter

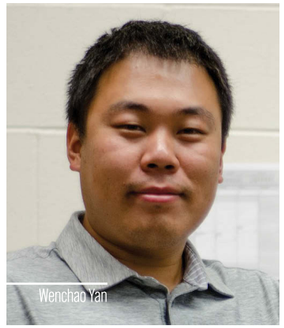
Donald Umstadter and colleagues at the UNL's Extreme Light Laboratory fired their Diocles Laser at a beam of electrons to measure how the laser's photons … scattered from a single electron after striking it. Under typical conditions, as when light from a bulb or the Sun strikes a surface, that scattering phenomenon makes vision possible. But an electron … normally scatters just one photon of light at a time. And the average electron rarely enjoys even that privilege, Umstadter said, getting struck only once every four months or so.

Though previous laser-based experiments had scattered a few photons from the same electron, Umstadter's team managed to scatter nearly 1,000 photons at a time. At the ultra-high intensities produced by the laser, both the photons and electron behaved much differently than usual.

"When we have this unimaginably bright light, it turns out that the scattering — this fundamental thing that makes everything visible — fundamentally changes in nature," said Umstadter, the Leland and Dorothy Olson Professor of Physics and Astronomy…. "So, it's as if things appear differently as you turn up the brightness of the light, which is not something you normally would experience," Umstadter said. "(An object) normally becomes brighter, but otherwise, it looks just like it did with a lower light level. But here, the light is changing (the object's) appearance. The light's coming off at different angles, with different colors, depending on how bright it is."

That phenomenon stemmed partly from a change in the electron, which abandoned its usual up-and-down motion in favor of a figure-8 flight pattern [see image]. As it would under normal conditions, the electron also ejected its own photon, which was jarred loose by the energy of the incoming photons. But the researchers found that the ejected photon absorbed the collective energy of all the scattered photons, granting it the energy and wavelength of an X-ray. The unique properties of that X-ray might be applied in multiple ways, Umstadter said. Its extreme but narrow range of energy, combined with its extraordinarily short duration, could help generate three-dimensional images on the nanoscale while reducing the dose necessary to produce them.

Using a laser focused to the brightest intensity yet recorded, physicists at the Extreme Light Laboratory produced unique X-ray pulses …[whose capabilities they demonstrated by using them to image] the circuitry of a USB drive. Those qualities might qualify it to hunt for tumors or microfractures that elude conventional X-rays, to map the molecular landscapes of nanoscopic materials now finding their way into semiconductor technology, or to detect increasingly sophisticated threats at security checkpoints. Atomic and molecular physicists could also employ the X-rays as a form of ultrafast camera to capture snapshots of electron motion or chemical reactions.

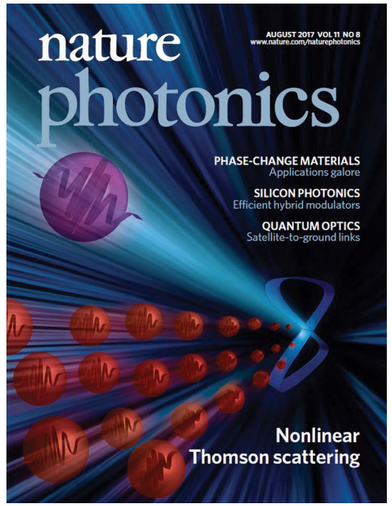

Wenchao Yan

"Since our X-ray device fits in a hospital or factory, it can be more widely used than conventional alternatives," said lead author, Postdoctoral Research Associate **Wenchao Yan**.

Umstadter, Yan and their colleagues also expressed excitement for the scientific implications of their experiment. By establishing a relationship between the laser's brightness and the properties of its scattered light, the team confirmed a recently proposed method for measuring a laser's peak intensity. The study also supported several longstanding hypotheses that technological limitations had kept physicists from directly testing.

"There were many theories, for many years, that had never been tested in the lab, because we never had a bright-enough light source to actually do the experiment," Umstadter said. "There were various predictions for what would happen, and we have confirmed some of those predictions. It's all part of what we call electrodynamics. There are textbooks on classical electrodynamics that all physicists learn. So, this, in a sense, was really a textbook experiment."

Umstadter and Yan authored the study with Research Associate Professors **Sudeep Banerjee** and **Shouyuan Chen**, Senior Research Associates **Grigory Golovin** and **Cheng Liu**, Postdoctoral Research



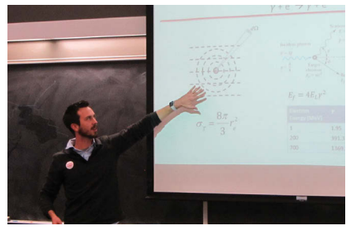
Associates **Ping Zhang**, **Baozhen Zhao** and **Jun Zhang**, graduate students **Colton Fruhling** and **Daniel Haden**, along with Min Chen and Ji Luo of Shanghai Jiao Tong University.

The team received support from the Air Force Office for Scientific Research, the National Science Foundation, the U.S. Department of Energy's Office of Science, the Department of Homeland Security's Domestic Nuclear Detection Office, and the National Science Foundation of China.

The research explores high-order multiphoton Thomson scattering, where hundreds of discrete photons are simultaneously scattered from individual electrons. Evidence for the highly nonlinear electron motion is seen from the spatial profiles of the x-ray beams, which became elongated along the direction of laser polarization as the strength of the light fields increased and the electron's figure-8 orbit became more pronounced. To achieve the requisite light intensity, an ultra-powerful laser was focused to 1020 times higher than that of sunlight on Earth.

Grad Students Arrange Own Seminar Series

In Spring 2016, graduate students **Nathan Clayburn** (M.S. 2012, Ph.D. 2017; Advisor: **Timothy Gay**) and **Keith Foreman** (M.S. 2012, Ph.D. 2017; Advisor: **Shireen Adenwalla**) began a graduate student seminar open only to graduate students. Its purpose was to allow "graduate students to learn about the work of fellow graduate students and practice their presentation skills in an informal, friendly environment." Nearly all of the seminars are by current graduate students, who present their thesis-related work in engaging and pedagogical ways. Typically, many questions follow each presentation. On some occasions, two graduate students have presented a joint talk, such as the one entitled "A Crash Course on Laser Wakefield Acceleration and Thomson Scattering" by **Colton Fruhling** and **Dan Haden** on 8 November 2016.




Nina Hong

Additionally, some seminars address topics of high interest to graduate students, such as the hands-on workshop entitled "Harnessing the Power of LaTeX" offered by **Karl Ahrendsen** and **Andrew Vikartofsky** on 7 October 2016. Occasionally outside speakers are invited to present seminars on these topics, such as the talk on "Spectroscopic Ellipsometry" given on 5 April 2016 by **Nina Hong** (Ph.D. 2012; Advisor: **Shireen Adenwalla**), an Applications Physicist with the J.A. Woollam Co., or the talk on UNL's Funsize Physics Project (concerning how to communicate one's research effectively and compellingly to diverse audiences) given on 8 December 2017 by **Jocelyn Bosley**, assistant director for education and outreach of the Nebraska MRSEC.

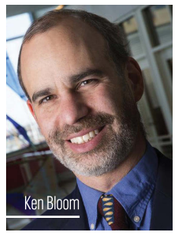

Jocelyn Bosley

A small amount of funding support from various Department grant sources allows the organizers to provide pizza at each seminar. In the 2017-18 academic year the Graduate Student Seminar is being organized by **Karl Ahrendsen** and **Pratyush Buragohain**.

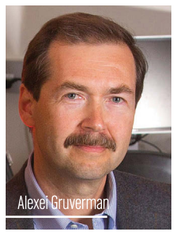
Claes, Bloom, and Gruverman Honored by Professional Societies

In the past two years three Department faculty have been honored by their colleagues, either by being elected Fellows of major professional societies or by receiving special society awards. In each case, these faculty were nominated by their peers and selected by the members of the respective society from among all nominations received.

In 2015, Professor and Chair **Daniel R. Claes** was elected a Fellow of the American Physical Society (APS) by the Forum on Education with the citation: *"For outstanding contributions to education initiatives associated with elementary particle physics, in particular to underserved remote rural communities."*



In 2016 Professor **Ken Bloom** was elected a Fellow of the APS by the Division of Particles and Fields with the citation: "*For the characterization of the top quark using data from Tevatron Collider and the Large Hadron Collider, and for leadership in computing for the Compact Muon Solenoid experiment.*"



In 2016 Charles Bessey Professor **Alexei Gruverman** was elected an International Fellow of the Japan Society of Applied Physics for "*Exploration of Critical Properties of Ferroelectric Materials Using Piezoelectric Force Microscopy.*" In addition, in 2017 he was selected by the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society for its Ferroelectrics Recognition Award with the citation: "For fundamental and applied studies of nanoscale physical phenomena using scanning probe microscopy."

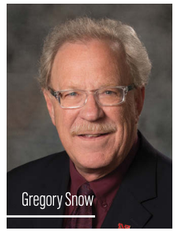
Centurion and Gay Awarded Named Professorships

In Spring 2017 two faculty were awarded named professorships based on their nomination materials and external letters of recommendation:

Associate Professor **Martin Centurion** was awarded a Susan J. Rosowski Professorship, which "recognizes faculty at the associate professor level for their contributions in research and teaching, who show exceptional promise for future excellence, and who have achieved distinguished records of scholarship or creative activity."

Professor **Timothy J. Gay** was awarded a Willa Cather Professorship, which was "established in 2001 by UNL to recognize faculty members with the rank of full professor who have established exceptional records of distinguished scholarship or creative activity."

Snow Elected U.S. CMS Collaboration Board Chair



Professor **Gregory R. Snow** was elected the Collaboration Board Chair for United States institutions collaborating on the Compact Muon Solenoid (CMS) experiment at CERN in Geneva, Switzerland. The two-year term began on June 1, 2016. As Board Chair, Snow represents the U.S. regarding CMS operations at CERN. The U.S. CMS Collaboration comprises 50 U.S. institutions and over 600 scientists, the single largest national representation on CMS. The Chair plays a critical role in guiding the involvement of the U.S. contingent on the experiment. Snow will also represent the U.S.-CMS collaboration during reviews of its science program and to funding agencies such as the National Science Foundation and the Department of Energy. Snow previously served as the Board's Deputy Chair.

Snow is a member of the Department's High Energy Physics team, which collaborates on the CMS experiment at the Large Hadron Collider (LHC). CMS researchers discovered the Higgs boson in 2012. After upgrades to the collider, researchers have resumed collecting data using new components for the CMS detector constructed by teams such as Nebraska's.

Leung Named Director of ISYA

Professor Emeritus **Kam-Ching Leung** has been selected as the Director of the International Schools for Young Astronomers (ISYA). ISYA was created in 1967 to "broaden the participants' perspective on astronomy by lectures from an international faculty on selected topics of astronomy, seminars, practical exercises and observations, and exchange of experiences," according to the International Astronomical Union (IAU). The Director works with local ISYA school leaders to develop the series of lectures, to ensure the academic level of the course, coordinate teaching faculty, etc. Leung has actively participated in this school since 1990.

Kam-Ching Leung (first row, left, with off-white jacket) at the 2017 School in Addis Ababa, Ethiopia

Leung has also been named a member of the Office for Young Astronomers (OYA) Steering Committee. The OYA Steering Committee was created to support the mission of ISYA, and is responsible for the organizational and financial aspects of ISYA. The Norwegian Academy of Science and Letters (NASL) and the IAU established OYA in 2015.

ISYA generally offers a three-week postgraduate experience for international students in regions where students have less opportunity to be directly exposed to the full extent of up-to-date astrophysics. During the school both theory and observations are addressed. The participants are essentially coming from countries in the region of the country hosting the ISYA. The lecturers are experts coming from all over the world. Starting from 2017 the School has expanded from one School per year to three Schools over two years. Thus, in 2017 there was a School in Addis Ababa, Ethiopia, and in 2018 there will be Schools in both Egypt and Colombia.

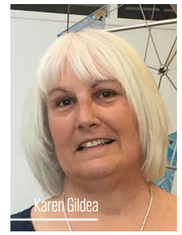
Lee Returns from NSF

Research Associate Professor **Kevin M. Lee** returned in August 2017 from a three-year leave of absence at the National Science Foundation (NSF) where he served as a rotating Program Director in the Division of Undergraduate Education (DUE) within the Directorate for Education and Human Resources (EHR). DUE's programs are intended to strengthen STEM education at colleges and universities by improving curricula, instruction, laboratories, infrastructure, assessment, diversity of students and faculty, and collaborations. Lee served as the Physics Discipline Lead for the IUSE Program (Improving Undergraduate STEM Education, DUE's largest program) and as a Co-Lead of the S-STEM Program (Scholarships for Science, Technology, Engineering, & Mathematics Students). Lee was responsible for all aspects of the NSF grant process including management of proposal reviews, chairing review panels, and making funding recommendations.

On 25 January 2018 Lee gave a seminar entitled "Experiences as an NSF Rotator" to UNL's Center for Science, Mathematics, and Computer Education. He said that the workload as an NSF program manager is heavy and that one must learn on the job. However, he noted that fellow program managers at NSF are extremely collegial and willing to assist when difficult issues arise. He pointed out also that NSF's EHR Division faces great scrutiny from Congress owing to its focus on education.

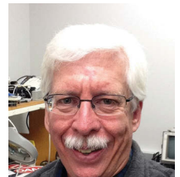
Gildea Receives A&S Applause Award

Karen Gildea, an Administrative Technician in our Department's Business Office, was honored by the College of Arts & Sciences with an Applause Award in November 2015. Her nominators noted that over the past dozen years she has become a "valuable asset to the Department." She was cited for her "impressive effectiveness, accuracy, and professionalism," for her deep knowledge of university accounting systems and transaction records, and for her willingness to step in and help when needed. The College's Applause program is a "monthly award honoring college employees who perform their jobs extraordinarily well!" It "recognizes innovative ideas, consistently outstanding performance, or service above and beyond the call of duty."



Kelty Retires

John (Bob) Kelty, Electronic Shop Manager for the Department retired in December 2015 after 36 years at UNL. He received his bachelor's, master's, and doctoral degrees in Electrical Engineering from UNL. In his initial years with the Department, most Electronics Shop work entailed design, construction, and repair of specialized electronic components. The advent of the personal computer brought huge changes in the role of the Electronics Shop: nowadays a large share of the work involves repair and updating of computer hardware and software as well as interfacing computers to experiments. As Electronics Shop Manager, Kelty ably led the Department through these tremendous changes. He also taught our Electrical and Electronics Circuits course to physics undergraduates for many years.



Kelty was also involved in polar ice cap research. He conducted research on polar ice sampling probes, including updating borehole logging systems with microprocessors and logging the deep boreholes in the Antarctic and in Greenland. He developed an ice sampling melting probe for an Arctic and Antarctic ice sheet study and was a coinvestigator for the Snow and Ice Research Group (SIRG) proposal to the NASA Earth Science and Applications Division. His work in this area led to a number of peer-reviewed publications, including a *Physical Review Letter* entitled "Test of Newton's Inverse-Square Law in the Greenland Ice Cap" [M. E. Ander *et al., Phys. Rev. Lett.* **62**, 985 (1989)].

Most recently, Kelty has been involved in the Phase-I upgrades for the CMS experiment at CERN's Large Hadron Collider in Geneva, Switzerland. He played a leading role in commissioning the wire bonding for the module fabrication used in the pixel upgrades. He also designed boards, now used by the USCMS pixel labs, for the manufacturing tests, equipment tests, and calibration of the pixel upgrade.

Kelty is a member of the Institute of Electrical and Electronic Engineers (IEEE) and of Sigma Xi, The Scientific Research Society.

Faculty Transitions: Dominguez and Enders Move to New Positions

In Fall 2016 two Department Faculty moved to new positions at other universities.

Professor **Aaron Dominguez** is the new Dean of the School of Arts and Sciences at The Catholic University of America in Washington, D.C. That School comprises 18 departments and

BRIEFLY NOTED...

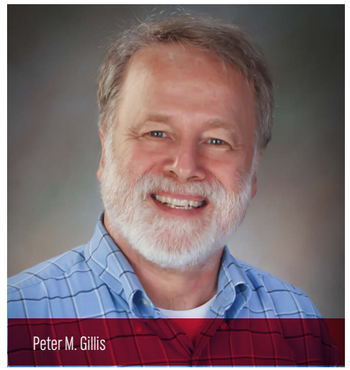
7 special programs. Dominguez joined our Department's High Energy Physics (HEP) group in 2004. He received a prestigious NSF CAREER grant for his research focused on searches for the Higgs boson. Most recently, Dominguez led the collaboration involving eight universities to upgrade the Compact Muon Solenoid (CMS) at the Large Hadron Collider in Geneva, Switzerland. He also served as Associate Dean for Research and Partnerships in UNL's College of Arts and Sciences. Dominguez retains an Adjunct Professor position at UNL in the Department's HEP group.

Associate Professor **Axel Enders** is now a full Professor of Physics at the University of Bayreuth, Germany where he leads an experimental group studying surface-supported self-assembled nanostructures. Enders joined our Department's condensed matter physics (CMP) group in 2007, adding to the group's strength in nanoscale magnetism and bringing expertise in scanning tunneling microscopy for magnetic imaging with atomic resolution. He received a prestigious NSF CAREER grant for research on "Self-Assembled Magnetic Nanostructures." As part of the outreach portion of that grant, he initiated the Department's annual Undergraduate Women in Physical Sciences (WoPhyS) conference in 2009, which has grown considerably in both attendance and renown over the years. Enders retains an Adjunct Professor position at UNL in the Department's CMP group.


Axel Enders

ALUMNI NEWS

Gillis Reminisces


Peter M. Gillis

Gillis, Peter M. (M.S. 1982; *Advisor: Duane Jaecks*) retired to Statham, GA, in 2016. He writes that after graduating in 1982, he worked for the Navy at the Naval Air Warfare Center Weapons Division at China Lake and Point Mugu, CA. The jobs were "straightforward engineering- radar, RF, and microwave electronics, including high power transmitters." The work involved design, testing, and integration of equipment as well as some project management, systems engineering, and proposal writing. He went to work in industry over two periods: from 1985-89 and from 1999-2016, at Lockheed Martin in Syracuse New York, Continental Electronics, Norden Systems, and the Georgia Tech Research Institute (GTRI) but returned to China Lake from 1989-99. He says, "I was fortunate in returning to China Lake…as I had stable employment through the 1990s, despite the reductions to the defense budget following the collapse of the Soviet Union. Living at China Lake was also interesting in that the location is quite remote, about 150 miles from Los Angeles in the northwest Mojave Desert. It really is the back of the beyond- about a million acres of test ranges and lab facilities, midway between Death Valley and the Sierra Nevada Mountains. I fell in love with the desert [and] still miss it a great deal." He notes that his "physics education was good preparation for learning on the fly, particularly in learning radar systems engineering and …how various microwave and RF components work." Email: petergillis95@gmail.com

Contact Us

Dan Claes, Chair, and Anthony Starace, Editor, encourage you to contact us with your news and comments. Alumni can email physicsalumni@unl.edu with news, address changes, contact information, etc. To contact us individually, our emails are dclaes@unl.edu and astarace1@unl.edu. News about the Department is also posted on our website at http://www.unl.edu/physics. Please join our new LinkedIn group for students and alumni: https://www.linkedin.com/grp/home?gid=8368473.

ALUMNI NEWS

Richards-Kortum Awarded MacArthur Fellowship

Rebecca Richards-Kortum (B.S. 1985) was selected as one of the 2016 MacArthur Fellows by the John D. and Catherine T. MacArthur Foundation. According to the Foundation's press release, "Richards-Kortum is a bioengineer addressing global health disparities in low-resource settings by developing point-of-care medical technologies and a new approach to engineering education. Drawing from nanotechnology, molecular imaging, and microfabrication techniques, [she] has created numerous low-cost and highly practical medical tools. For example, she and collaborators have invented methods for diagnosis of oral, esophageal, and cervical cancers that overcome the challenges posed by invasive biopsies and multiple follow-up appointments in developing countries….


Rebecca Richards-Kortum

"Richards-Kortum spends significant time working directly with hospitals, community groups, and rural practitioners in Malawi, Rwanda, El Salvador, Brazil, and elsewhere to ensure her inventions are robust and reliable in local settings. These visits also enable her to identify needs, evaluate the impact of proposed solutions, and gather feedback for improvements. In addition to her own research, Richards-Kortum co-founded Beyond Traditional Borders (BTB), an undergraduate curriculum focused on translating classroom concepts into solutions for global health problems."

After graduating with a B.S. degree from Nebraska, Richards-Kortum received her M.S. and Ph.D. from the Massachusetts Institute of Technology. She worked for several years at the University of Texas at Austin before joining Rice University in 2005. At Rice, she is currently the Malcolm Gillis University Professor in the Departments of Bioengineering and Electrical and Computer Engineering. She is also the founder (2007) and director of the Rice 360° Institute of Global Health and the author of the textbook Biomedical Engineering for Global Health (2010).

Read more about her research and career in the MacArthur Foundation press release. NPR, the Chicago Tribune, and the Wall St. Journal (in a feature story on 24 June 2017), among others, also provided coverage of the fellowship award. Richards-Kortum's election to the National Academy of Sciences was reported in the 2015 issue of Spectrum. The MacArthur Foundation "supports creative people, effective institutions, and influential networks building a more just, verdant, and peaceful world."

Lang Appointed Director of the APS X-Ray Science Division

Argonne National Laboratory announced on 19 September 2016 the appointment of *Jonathan C. Lang* (B.S. 1988) as Director of the X-ray Science Division (XSD) at the Advanced Photon Source (APS). Since 2013 he has been Associate Division Director of XSD. According to Argonne's news release, "throughout his career at Argonne, he has demonstrated strong leadership, project management skills and research abilities, which make him the ideal person for this important job.

"In his new role as the Director of the X-ray Science Division, Lang will be responsible for leading a division that provides critical expertise and support for the APS user community, as well as mentoring the next generation of X-ray scientists and fostering a vibrant research environment. In addition, Lang will join the Photon Sciences Directorate Senior Management Team and will be tasked with delivering the excellence in X-ray sciences that will continue to maintain the world-leading stature of the APS scientific program."

Following receipt of his B.S. degree at UNL, Lang earned his Ph.D. in condensed matter physics at Iowa State University. He was a postdoctoral research associate in the APS Experimental Facilities Division at Argonne from 1993 to 1996 and subsequently obtained a permanent position there. Among other positions at the APS, Lang has served as Group Leader for Magnetic Materials. His research interests have focused on developing instrumentation and techniques that employ the polarization properties of synchrotron radiation to probe magnetic systems, particularly rare earth - transition metal compounds in extreme environments, such as high-magnetic and electric fields, high-pressures, and low temperatures.


Jonathan C. Lang

Bruegman Receives Silver Sherman Award

In May 2016 *Otto W. Bruegman* (B.S. 1984, M.S. 1987) received the Silver Sherman Award from the National Oceanic and Atmospheric Administration (NOAA). The Silver Sherman is awarded on an ad hoc basis by members of the NOAA Senior Executive Service in recognition of work performed above normal requirements, achieving a milestone that contributes significantly toward the attainment of a particular program goal, and/or demonstrating leadership toward process improvement of a significant magnitude. Bruegman received the award for his leadership and timely corrective actions taken when faced with debris in a critical component in NOAA's satellites used for atmospheric data gathering. We asked Otto to provide more details on the crisis situation he faced that led to the award. We reproduce his (slightly edited) response below.


Otto W. Bruegman

"I joined NOAA in July 2009. In September 2010 I became the Instrument Manager (IM) for the Advanced Technology Microwave Sounder (ATMS), which detects radio waves emitted by the Earth's atmosphere. The ATMS measures radio frequency (RF) energies in 22 channels (wavelengths). Each channel detects the total power of RF energy created by gases (O2 for Temperature and H2O for water vapor) at different altitudes in the Earth's atmosphere. These data are then used to determine altitude-specific temperature and humidity used in the NOAA weather models to provide weather forecasts.

"The advantage of the ATMS, using frequencies ranging from 23-183 GHz, is that it can 'see' from space to surface level through all atmospheric conditions (clouds, etc.). That makes it the most important instrument for weather forecasting. The NASA Goddard Space Flight Center (GSFC) procures the satellite for NOAA under the Joint Polar Satellite System (JPSS) Program. As the IM for ATMS, I am part of the GSFC JPSS Flight Project. During integration and testing of the ATMS instrument, my team found a conductive piece of foreign object debris in a key ATMS subsystem. I asked my team and the instrument vendor to conduct a risk analysis to determine if more foreign object debris (of similar shape and size) remained in the instrument. The risk analysis indicated the potential for catastrophic instrument failure in orbit. That resulted in a two-year effort to de-integrate, clean, and reintegrate the suspect subsystem. It included extended hour days and weekend work. In that timeframe I also led the procurement effort that put two more ATMS instruments on contract for the JPSS Program.

"The Silver Sherman Award was recognition from NOAA for my efforts. In addition, NASA recognized my efforts by promoting me to JPSS Instrument Systems Manager for the ATMS and Visible Infrared Imaging Radiometer Suite (VIIRS) instruments. The period from 2010 to the launch (18 October 2017) of the JPSS-1 satellite (now called NOAA-20) has been a very interesting ride. Based on all the anomalies that occurred in that timeframe with the ATMS instrument, I am quite sure I could teach an engineering course on `what could go wrong and how to prevent it' for developing instruments for space applications.

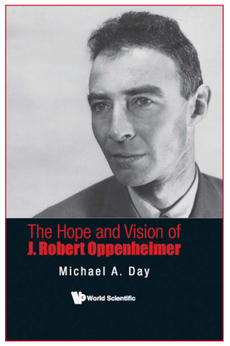
"The ATMS instrument is now in orbit and has been returning data since early December 2017. It is proving to be the best performing microwave sounder in the NOAA space-based fleet."

Otto works in Lanham, MD. His email address is: otto.w.bruegman@nasa.gov

Day Writes Book on Oppenheimer

Michael A. Day (M.S. 1978, Ph.D. 1983; *Advisor: Robert J. Hardy*) has written a book on J. Robert Oppenheimer, the theoretical physicist on the faculty at the University of California at Berkeley who was the head of Los Alamos Laboratory during WWII. The aim of Day's book, *The Hope and Vision of J. Robert Oppenheimer* (World Scientific, 2015), "is to set forth and develop Oppenheimer's views on science, society, and the nuclear revolution." In the book, Day examines what Oppenheimer said and wrote during the 1940s, 50s and 60s (i.e., his hope and vision) with the goal of identifying what might be of general philosophical interest today. Day's analysis reveals ways in which Oppenheimer's reasoning was prescient of current work being carried out to control, and possibly move beyond, the nuclear revolution. In a YouTube video, Day discusses the unique perspective of his book: https://www.youtube.com/watch?v=Xv43npiMp64


Michael A. Day



According to Day, this book represents the culmination of his research over more than twenty years on American Cold War physicists and their views on science and society. Based on this research, Day was named a Fellow of the American Physical Society (APS) in 2010. He was nominated by the APS Forum on the History of Physics with the following citation: "For his thoughtful research, publications, and public presentations on the views of Oppenheimer, Rabi, and Condon concerning science and society."

Prior to earning his physics Ph.D. in 1983 (specializing on the theoretical description of anharmonic solids and their properties), Day earned a Ph.D. in philosophy at UNL in 1977 and, after obtaining his M.S. in physics in 1978, worked for two years (1979-81) as a geophysicist in the International Division (Africa and South America) of Shell Oil Company, before returning to complete his doctoral studies in physics. Then, following four years as a junior faculty member at Thiel College in Greenville, PA, Day joined the faculty at Lebanon Valley College, a small liberal arts institution in Annville, PA, where he became a Professor of Physics and served as Department Chair for nearly a decade. During the 1996-97 academic year, Day was a Visiting Professor of physics and philosophy at Nanjing University, China. In 2017 Day retired from Lebanon Valley College, but still teaches physics there as an adjunct faculty member.

Calabrese Advocates for Science

Editor's Note: An article titled "APS Members Make Gains with Science Advocacy" by T.W. Johnson in the August/September 2017 issue of APS News focused on the experiences of alumnus Dominic Calabrese (M.S. 1988, Ph.D.1993; Advisor: Duane H. Jaecks). Below are excerpts from the article.

APS members are making big moves in the science policy arena, helping to ensure that the U.S. maintains robust science budgets to keep the nation on a path of jobs and prosperity. *Dominic Calabrese*, a physics professor at Sierra College in Rocklin, California, working with the APS Office of Public Affairs (OPA), landed an op-ed in the Auburn Journal, urging his representative Tom McClintock (CA-4th) to reject … proposed cuts to science. McClintock serves on the House Committee on the Budget, and thus plays an integral role in funding decisions….

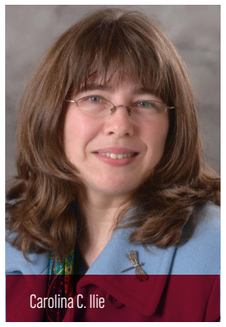
Calabrese said it is crucial that scientists educate members of Congress on the importance of science. "Very few politicians in Washington, D.C. and the state and local levels have a background in the sciences," he said. "They are making decisions on bills that directly affect the livelihood of many educators and professionals in the scientific community, and I felt I had to voice my concerns regarding science funding."


Dominic Calabrese

Calabrese added, "My involvement (in science advocacy) has given me the chance to make a difference in the lives of the members of the science community. It has also allowed me to be heard by my congressional representative. Lastly, I hope my involvement has increased our congressional district's awareness of the significance of federal science funding."

Calabrese took his advocacy a step further by meeting with McClintock's staff in his local office, along with Greg Mack, APS government policy specialist, to underscore key points in his op-ed. McClintock's staffers — both locally and in Washington, D.C., have responded in a favorable manner toward the importance of funding science.

Ilie Honored for Teaching Excellence

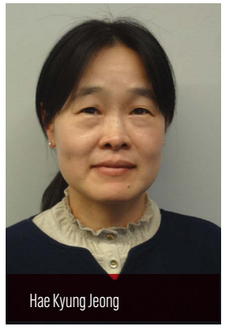

Carolina C. Ilie

Carolina C. Ilie (Ph.D. 2008; *Advisor: Peter A. Dowben*) received the 2016 President's Award for Teaching Excellence from Deborah F. Stanley, the President of the State University of New York (SUNY) at Oswego. According to SUNY-Oswego's news release, "Ilie has distinguished herself as a students-first teacher and mentor, constantly encouraging and teaming with undergraduates to produce quality research projects and publications that build skills leading to success in graduate schools and careers." Her students praised her for her energetic teaching, her helpfulness in learning, and her mentorship. Her Department Chair noted that she "has established herself as an excellent teacher" of both introductory and advanced physics courses. Recently, in fact, Ilie co-authored a problem-solving textbook with one of her former students: C.C. Ilie and Z.S. Schrecengost, *Electromagnetism: Problems and Solutions* (Morgan & Claypool, San Rafael, CA, 2016). They currently have another book in press, *Electrodynamics: Problems and Solutions*, with the same publisher.

In addition to teaching, Carolina Ilie continues her research in condensed matter physics during summers. At SUNY-Oswego she has a laboratory with capabilities for thin film fabrication and characterization, electric transport measurements, and thermal desorption of molecules from polymer films. In the summers of 2016 and 2017, Ilie returned to UNL with two students to continue collaborative research with Peter Dowben and **Axel Enders**. These visits were supported by UNL's Materials Research Science and Engineering Center (MRSEC).

Prior to entering the physics Ph.D. program at UNL, Ilie received her B.S. degree in engineering physics from the University of Bucharest, Romania, in 1994 and her M.S. degree in physics from Ohio State University in 2003. While at UNL, she married **Ildar Sabirianov** (M.S. 2005, Ph.D. 2005; *Advisor: Bernard Doudin*). Ilie is currently an Associate Professor in the physics department at SUNY-Oswego and Sabirianov is a Lecturer there. They have two sons, ages 11 and 6.

Jeong Returns for Sabbatical


Hae Kyung Jeong

Hae Kyung Jeong (Ph.D. 2003; *Advisor: Peter A. Dowben*) returned to the Department in January 2016 for her one-year sabbatical leave. Jeong is a Professor in the Physics Department at Daegu University, a private university in Gyeongsan, South Korea. She received her B.S. from ChonBuk National University and her M.S. degree from Pohang University of Science and Technology in South Korea. After completing postdoctoral appointments at UNL and Brookhaven National Laboratory, she moved to South Korea as a research professor at Sungkyunkwan University. She joined Daegu University in 2010. Prof. Jeong's research interests are in carbon-based materials and two-dimensional materials for applications to energy storage devices, bio-sensors, catalysts, and conducting flexible devices.

As our Recognition Luncheon speaker in May 2016, Prof. Jeong reflected on her time as a graduate student at UNL. She shared fun memories of her time in the Department, which included activities such as horseback riding and fishing, and dealing with what she characterized as "extreme weather." Her presentation was illustrated with many photos, including one of Prof. **Peter Dowben** riding a horse, much to the delight of the audience. She noted that one needs a good team to succeed in a physics career, and the Dowben group was such a team. Prof. Jeong also shared personal opinions of the many other professors and staff members with whom she enjoyed working, including learning from Prof. **Timothy Gay** how to detect electron spin polarization with a Mott detector.

Prof. Jeong related the difficulty she experienced in finding a faculty position. She applied for more than thirty faculty positions and went through seven interviews before getting her current position at Daegu. This was frustrating for her, but now she has a successful and growing lab with a very international group of students. In her lab she developed the capability to make her own samples, such as graphene and carbon nanotubes. In both 2014 and 2016 she won her college's research award and in 2015 she was only the second person to win her university's Global Research Award. Prof. Jeong has now begun producing her own Ph.D. students.

In her Recognition Luncheon speech, she offered the following advice to our students:

(1) *Never give up!* Even if you have a setback, you can regain your energy and move forward again.

(2) *Be the best in your area of research.* Motivation can get you started, but it's good habits and diligent work that will keep you going. At the same time, it is important to enjoy the work.

(3) *Stay healthy in both body and mind.* Prof. Jeong has run four marathons, including the 2016 Omaha marathon. (She arrived too late to register for the Lincoln marathon, but served as a volunteer.)

While on sabbatical at UNL she is working on photoemission and inverse photoemission measurements of MoS_2 and optical measurement of carbon composites with cholesterol. She is mapping the electron spin structures of these materials. She has also enjoyed meeting more people and making more good memories in our Department.

By Ken Bloom and Anthony Starace

Poulsen Speaks at 2017 Recognition Luncheon


Matthew A. Poulsen

Matthew A. Poulsen (B.S. 2000, M.S. 2002, Ph.D. 2007; *Advisor: Stephen Ducharme*) was the featured alumnus at the Recognition Luncheon held on 4 May 2017. The luncheon honors the Department's bachelor's, master's, and doctoral degree recipients. They are addressed by one of our distinguished alumni, often selected from among those who have forged a successful career outside of academe (with which our students are already familiar). Matt Poulsen is a patent lawyer and co-owner of Suiter Swantz IP, a major Intellectual Property (IP) law firm that provides patent, trademark, and copyright services for a wide array of clients ranging from startups and individual inventors to multi-billion dollar corporations. Based in Omaha, Suiter Swantz IP works with clients from across the U.S. and around the world.

At UNL, Matt's physics research focused on electroactive polymer systems, including the development and study of new ferroelectric polymer systems. Subsequent to receiving his Ph.D. in physics, Matt entered the UNL College of Law, obtaining his J.D. degree in 2010. He joined Suiter Swantz IP in Omaha as a technical advisor in 2007 and as a patent attorney in 2010. He is now one of four co-owners of the firm. Poulsen's practice is focused on IP procurement and protection, including U.S. and foreign patent preparation and prosecution, among other matters. His clients operate in a variety of technological areas, including optics, semiconductor fabrication and testing, nanotechnology, nuclear and renewable energy, biofuels, telecommunications, agricultural technology, etc.

Poulsen said that in his law school class of 120 students, only 3 had scientific technical training. Following graduation, he explained that to become a patent attorney he had to pass both the regular bar exam to practice in Nebraska and the patent bar exam, in order to practice before the U.S. Patent Office. He said a Ph.D. in physics is not essential for becoming a patent lawyer, but that it gives one valuable credibility in meeting with clients in high tech companies. Also, his scientific training in physics has been very valuable to his career success. Furthermore, he enjoys the fact that his day-to-day activities are highly varied and mostly focused on high tech matters.

We Heard That...


Steven G. Alston

Alston, Steven G. (M.S. 1979, Ph.D. 1982; *Adviser: Joseph Macek*) is Chair of the Natural Sciences at Campbellsville University in Campbellsville, KY. Email: salston@campbellsville.edu


Bogdan Borca

Borca, Bogdan (M.S. 1998; Ph.D. 2001; *Advisor: Anthony Starace*) is now working as a risk analyst for UBS in Zürich, Switzerland. Email: bborca@gmail.com

Dreiling, Joan (M.S. 2010, Ph.D. 2014; *Adviser: Timothy Gay*) took a position on the scientific staff of the Honeywell Corporation in Broomfield, CO. Email: jmdreiling2@gmail.com

Istomin, Andrei (M.S. 2002, Ph.D. 2005: *Advisor: Anthony Starace*) is a manager at Bidz.com heading a team of 11 engineers in Los Angeles, Lithuania, and Ukraine. Email: ayistomin@gmail.com

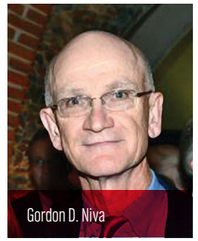

Shawn Langan

Langan, Shawn (B.S. 2002, M.S. 2013; *Adviser: Edward C. Schmidt*) has taken a position in the Science Department at The British School in Warsaw, Poland. The British School in Warsaw belongs to Nord Anglia Education, which is "a family of over 50 international schools, boarding schools and private schools located in 24 countries around the world …[that] educate more than 49,000 students between the ages of 2 and 18 years old." Shawn teaches physics and tutors grade 12 students there. From 2006 to 2017, Shawn was the Department's Laboratory Manager. In that role the College of Arts and Sciences named him an "Academic Star" in 2012 (see p. 13 of the Spring 2014 issue of Spectrum). Email: Shawn.Langan@thebritishschool.pl


Jing Liu

Liu, Jing (M.S. 2006, Ph.D. 2011; *Adviser: Peter Dowben*) is an Assistant Professor of Physics at Manhattan College in Riverdale, NY. Email: jliu04@manhattan.edu

Machacek, Joshua (M.S. 2009; *Adviser: Timothy Gay*) is an ARC DECRA Research Fellow in the Research School of Physics & Engineering at the Australian National University. Email: joshua.machacek@anu.edu.au


Gordon D. Niva

Niva, Gordon D. (M.S. 1975, Ph.D. 1979; *Adviser: Edward C. Schmidt*) retired from Boeing in 2011 and has since served as an aerospace consultant for small businesses and for Boeing. He recently led a successful Boeing proposal for $349M for a new command and control (C2) system for the planned ICBM upgrade to the Minuteman missile. Gordon and his wife Susan ran in their 33rd Los Angeles marathon in March 2018. Email: astropharm@aol.com

Park, Chang-Hwan (Ph.D. 1984: *Advisor: Anthony Starace*) is retired (as a medical physicist) and living in Los Angeles, CA. Email: hpark111@gmail.com

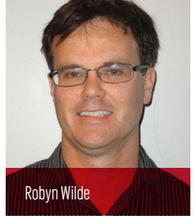
Pirbhai, Munir (Ph.D. 2013; *Adviser: Timothy Gay*) joined St. Lawrence University in Canton, NY as an Assistant Professor of Physics. Email: mpirbhai@stlawu.edu

Poddar, Shashi (M.S. 2011, Ph.D. 2014; *Adviser: Stephen Ducharme*) is a postdoctoral researcher with Professor Alain Jonas in the Institute of Condensed Matter and Nanosciences at the Université catholique de Louvain in Louvain-la-neuve, Belgium. Email: shashi.poddar@uclouvain.be


Shashi Poddar

Poulsen, Matthew (B.S. 2000, M.S. 2002, Ph.D. 2007; *Adviser: Stephen Ducharme*) was selected as a 2016-2017 Rising Star by Super Lawyers, a research-driven, peer-influenced rating service of lawyers who have attained high professional achievement and peer recognition. Email: map@suiter.com

Reece, Timothy (M.S. 2002, Ph.D. 2007; *Adviser: Stephen Ducharme*) was promoted to Associate Professor with Tenure and Department Chair at the University of Nebraska at Kearney. Email: reecetj@unk.edu


Robyn Wilde

Wilde, Robyn (M.S. 1996, Ph.D. 2000; *Adviser: Ilya Fabrikant*) has been promoted to the rank of full Professor at the Oregon Institute of Technology. He continues to collaborate with Ilya Fabrikant on the theory of positronium collisions with atoms and molecules. Email: Robyn.Wilde@oit.edu

Paul R. Byerly (1922-2016)

Emeritus Associate Professor **Paul Robertson Byerly, Jr.**, died on 18 June 2016 in Lincoln. He was 93.

Byerly joined the Department in 1963, hired by Professor **Edward Zimmerman**, Department Chair, during a time of significant growth in the number of Department faculty. He taught in the Department until his retirement in 1985. His research interests centered on the Mossbauer Effect. Over his career, he supervised the doctoral research of two graduate students: **Louis J. Caplan** (M.S. 1963, Ph.D. 1974) and **Donald E. Shult** (Ph.D. 1976). Byerly is remembered for being the Department's computer expert in the early days of punch cards, with interests in computer-assisted instruction and animated movies.

Paul Byerly was born and raised in Lancaster, PA, where he attended McCaskey High School. He received an A.B. degree from Washington and Jefferson College in Washington, PA, in 1943 and a Ph.D. from University of Pennsylvania in 1951.

Prior to joining UNL, Byerly served as a scientist on the Manhattan Project at Oak Ridge National Laboratory and on the H-bomb project in Livermore, California, where he was a Senior Physicist with the University of California Radiation Laboratories. In 1958, he joined the State Department Agency for International Development (AID), with appointments as an education advisor in the Philippines and in Taiwan. In the book "The Origins of the Developmental State in Taiwan" by J. Megan Greene (Harvard U.P., Cambridge, MA, 2008) it is noted that Byerly advocated linking AID support for academic science to Taiwan's economic development.

By Amanda Lager and Anthony Starace

Catherine (Kay) Haley (1937-2017)

Former Graduate Program Secretary Catherine (Kay) Haley, 80, of Gretna, NE, died on 2 July 2017. Born in Tulsa, OK, Kay lived for several years and attended secondary school in California. She received her Associates Degree from the Lincoln School of Commerce, and began her career after raising five children.

Kay joined the Department in 1994 as a Word Processing Specialist. She was promoted in 1998 to Graduate "Program Secretary, in which position she served until her retirement in 2013. Among her duties, Kay assisted the Department's graduate student and graduate admissions committees. She also completed special projects for the Department, such as assisting Professor Emeritus **Sitaram Jaswal** to organize the Forty-Fourth Annual Midwest Solid State Conference held in Lincoln on October 18-19, 1996.

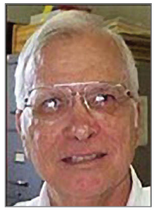
Faculty remember her for her "wry sense of humor about the physicists with which she worked."

Kay was recognized for her excellent service to the university in October 2001 with the College of Arts and Sciences Applause Award, given for innovation, outstanding performance, and service beyond the call of duty. One of her nominees said, "Kay's major responsibility is to process all the paperwork related to both new and present graduate students.... Actually, a more honest statement would be that she does all the 'real' work." Another said "… she is the workhorse of the Graduate Committee and goes out of her way to do it all with a smile.... "

Staff members recall that Kay had a generous heart and frequently volunteered in the community. Her many outreach activities included being a devoted blood donor. Nothing would stop Kay from giving to those in need.

By Amanda Lager

Robert J. Hardy (1935-2017)



Professor Emeritus Robert J. Hardy passed away on June 20, 2017 in Lincoln, Nebraska. He was born on January 26, 1935 in Port Angeles, Washington, received his B.S. degree in 1956 from Reed College in Portland, Oregon, and his Ph.D. degree in 1962 from Lehigh University in Bethlehem, Pennsylvania. He continued working for his thesis advisor, Professor J.A. McLennan, for a year and then joined the Center for Research and Advanced Studies in Mexico City the next year. During 1965-1967, he was a postdoctoral research associate at the University of Oregon with Professor G.H. Wannier, who introduced the famous Wannier functions.

Hardy joined our Department as an Assistant Professor in 1967 and was promoted to Full Professor in 1976. He remained at the UNL until his retirement in 2006. He served as the Vice Chair of the Department during 1984-1989. He spent a sabbatical year (1977-78) at the University of Bristol, England, and the University of California, Los Angeles. For several summers he was a visiting scientist at Lawrence Livermore National Laboratory (LLNL) in Livermore, CA.

Hardy's students remember him as "a patient teacher," and as a "wonderful person and a brilliant physicist." He was a "mentor and friend" who had a lasting impact. He was regarded as a dedicated, careful instructor, always starting with the simplest thoughtfully-designed problems and building incrementally from there. This culminated in his receiving a university-wide Distinguished Teaching Award in 1979.

Hardy was a theoretical physicist passionate about thermal physics and its applications to the study of the structural, mechanical, and transport properties of solids. He enjoyed discussing thermodynamic principles at length over a bagel and coffee at a neighborhood restaurant, or while walking to and from his daily bus ride. Because of this passion he participated in the June 2000 Gordon conference on Statistical & Thermal Physics that explored how research in physics and physics education can be used to improve the teaching of physics. He contributed "Why not use "ordinary" mathematics when teaching thermodynamics?" After teaching for several years, he started writing a book on the subject. When **Christian Binek** joined the Department, they started having lunch discussions about the book and Binek found that he appreciated Hardy's approach to the subject. After a couple of years of discussions, they published a 500-page book entitled *Thermodynamics and Statistical Mechanics: An Integrated Approach* (Wiley, 2014).

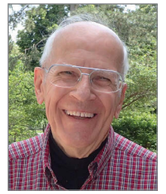
With his six Ph.D. students and several colleagues, Hardy developed theories to study thermodynamic properties and applied them to many materials. At LLNL he collaborated with Arnold Karo on the study of shock waves. He developed some fundamental formulas in shock physics, most notably in his paper "Formulas for determining local properties in molecular-dynamics simulations: Shock waves," *Journal of Chemical Physics* **76**, 622 (1982). His formulas for the conversion of discrete to continuum properties are still often cited in the field of shock waves and detonations. He was also cited as an Outstanding Referee by the editors of American Physical Society journals.

Bob Hardy was exacting, thorough and disciplined in both his physics and his other interests. Those other interests included steam trains, classic cars, wooden boats, and history from the Roman era to World War II. He seemingly never hurried, had an ironic sense of humor, and regularly expressed his love of family.

By Christian Binek, Sitaram Jaswal, and David Swanson

Loyd D. Jacobs (1932-2017)

Loyd D. Jacobs (M.S. 1958) of Bellevue, WA, passed away on March 9, 2017. Jacobs was a longtime, passionate supporter of the Department through his contributions to the Ted Jorgensen Fund for Physics, named after his renowned instructor, mentor and friend.



Born on November 22, 1932, Jacobs grew up in Kansas where he lived for most of his childhood in Lamont or Emporia. He attended Emporia High School and Emporia State University where he majored in physics, math and chemistry and served as a physics lab instructor. He received his B.A. with honors in 1954, and from there he came to UNL for graduate study and research in physics and math.

After receiving his degrees, Jacobs was employed by the Boeing Company, first in Wichita in 1957 and then in Seattle, WA from 1962 until his retirement in 1995. He specialized in the areas of noise engineering, structural dynamics, vibration and loads on both military and commercial aircraft. Following his retirement, he greatly enjoyed creating and designing a magnificent garden, pursuing extensive travel, and pursuing the joys of photography.

Jacobs was preceded in death by his wife Barbara ("Bobbie"), whom he met at UNL when she was a secretary in the Department, and by his son, John. He is survived by his children – Paul and Ann – and his close companion, Sue Olsen, with whom he visited Lincoln and toured the UNL campus several months prior to his passing.

"Loyd was truly inspirational," Joseph S. Francisco, Dean of the College of Arts and Sciences, reflects. "He represented to me how to really see the beauty of life, the robustness of relationships, and the value of people. We are so grateful to have known him, and for his ardent support over the years."

Emeritus Professor **Roger D. Kirby** recalls, "I first met Loyd when he attended the May 2003 reunion of students who worked in Ted Jorgensen's accelerator lab in the middle 1950s to late 1960s. These former students had formed close bonds and were delighted to renew old friendships." [*Editor's note: For a report and photos of this reunion, see p. 18 of the Fall 2004 issue of Spectrum.*]

As Department Chair at the time, Kirby and his wife Sue hosted a party for the visiting alumni at their home. "Loyd and his wife Barbara both attended, and Sue remembers that they brought us a package of dried Washington cherries as a gift – they were fantastic." The couples' friendship blossomed over the years, with reunions occurring each time the Jacobs' travels brought them through Lincoln.

Kirby recalls his conversation with Jacobs following the death of Professor Emeritus **Ted Jorgensen** (B.A. 1928), who passed away at the age of 100 on April 4, 2006. "I spoke with him over the phone, and he was astounded that no one had yet established an NU Foundation account in Ted's name." Without hesitation, the Jacobs' established the Ted Jorgensen Fund for Physics with a substantial donation. Jacobs' fellow alumni and peers, Department faculty, Jorgensen relatives and others soon donated enough for the fund to become endowed. Jacobs would continue to make generous contributions up until his passing, and his companion Sue Olsen recently honored him with a gift to the fund in his memory. Income from this fund provides fellowships and scholarships for deserving physics students each year, providing a lasting legacy.

"Loyd had many, many good qualities," Roger Kirby reflects. "But one thing especially stands out to me: He remembered from where he came and the debts he had to those who helped him reach his goals. He greatly appreciated the educational opportunities he received, and he recognized that what he learned and achieved through hard work enabled his later successes. He was a great and loyal friend to the Department, and I will miss him greatly."

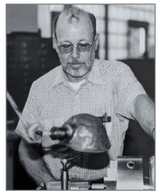
"Loyd's contributions have had an enormous impact," **Daniel R. Claes**, Professor and Chair of the Department, agrees. "By establishing and endowing the Ted Jorgensen Fund, he has helped us provide fellowships to attract excellent graduate students into our program, and stipends for a number of incoming graduate students."

Claes adds that, each year, these stipends enable students to attend a summer "bridging program" – offered to admitted students in need of making up a few deficiencies in their undergraduate preparations. Funds also have been used to assist outstanding undergraduate students struggling to meet tuition costs, and to sponsor prominent scientists to come speak to students about their work.

"The fact that Loyd did this all in Ted's name – note this isn't the 'Loyd Jacobs Fund' – wanting to honor an instructor he thought so highly of, speaks volumes to his generosity," Claes reflects.

Written by Sophia Werning

Loren A. Marks (1931-2017)



Loren Arthur Marks, 86, died on October 12, 2017 in Lincoln. Loren was born June 9, 1931 in Huntley, Nebraska. He served in the Air Force during the Korean War, following which he joined North American Aviation in Los Angeles, where he worked on the Apollo Lunar Module and other aerospace and defense projects.

Marks joined the Department as a machinist in 1972 and worked in the Instrument Shop until his retirement in 2000. Professor Emeritus Duane Jaecks noted that Marks "was an accomplished and skilled instrument maker when he started in our shop," noting that he had "honed his skills on the best and most advanced machine shop equipment" at the time.

Jaecks added, "I had the pleasure of working with him on several pieces of important research apparatus that were funded under my NSF grant. Since I designed each apparatus to fit the physics that was to be studied, we were always building a new apparatus. For example, Brian Moudry (M.S. 1989, Ph.D. 1995), a graduate student in my group, needed to have an entire vacuum chamber built before he could perform his Ph.D. thesis experiment. Loren successfully built the chamber to the high tolerances required."

"The bottom line," says Jaecks, "is that Loren Marks was a top notch machinist and instrument maker, who significantly enhanced the performance and quality of our shop."

Donald W. Miller (1935-2016)

Former electronics technician Donald Ward Miller, 80, of Alliance, NE, passed away on 8 May 2016. He was born in Milford, NE, on 4 November 1935. Miller began his career in electronics with the U.S. Air Force in Biloxi, MS. He then worked for Boeing in Wichita, KS, before joining the Department's Electronics Shop in 1978. After retiring in 1993, Donald moved to Alliance to live with one of his sons.

Those who interacted with Miller recall that he handled well the variety of daily electronic necessities in the Department, such as custom manufacturing, parts procurement, and general electrical repairs. Don almost always wore a white lab coat, which was badly stained from the ferric chloride used in making printed circuits at the time. He was always present in the shop to address immediate needs, which allowed other staff to handle electronics issues on site in the various Department laboratories. After work, during the season, Miller enjoyed live horse racing. He was buried in Milford.

Inge Worth (1923-2016)

Former department secretary Inge Worth died in Lincoln on 24 January 2016 at the age of 93. She was born in the Free City of Danzig on the Baltic Sea, Germany, on May 19, 1923. A Holocaust survivor, Inge donated her papers, "The Inge Worth Collection, 1868-2000," to the Leo Baeck Institute in New York, which states: "This collection contains a wide variety of material from Inge Worth and her family, reflecting Jewish life in Danzig from the late 19th century until its destruction in WWII." In 1965, she married Peter Worth, then Chairman of the Department of Art at UNL. Inge worked at Love Library for over ten years and then worked another ten years in the Physics Department's Main Office.

Inge Worth had many interests and talents. She was one of the five founders of the Lincoln Friends of Chamber Music and served as its treasurer for six years. She served as a translator for the American Historical Society of Germans from Russia. She made silver and copper jewelry and had a fine eye for art. For many years, she and her husband traveled extensively each summer in Europe, during which time Inge drove and Peter observed. In a photo mural by Lincoln artist Larry Roots (that is mounted on the north side of the skywalk on 12th Street between N and 0 streets in Lincoln), *the Worths are shown walking west.*

On 1 November 2017 it was announced in *Nebraska Today* that the Worths had donated more than $1 million through their estate to the Peter and Inge Worth Endowment Fund at the UN Foundation for the benefit of UNL's Hixson-Lied College of Fine and Performing Arts.

Bao Endows Faculty Travel Fund

MinQi Bao (M.S. 1992, Ph.D. 1995; *Advisor: Anthony F. Starace*) has established a permanent endowment fund with the University of Nebraska Foundation. The fund is named the "Dr. MinQi Bao Physics Faculty Travel Fund." Income from the principal of the fund is to be used to support travel by Department faculty, with preference for faculty "who are giving talks on their research at major scientific events..." and "who work in or with the Atomic, Molecular, Optical, and Plasma Physics groups." Bao is currently a Group Director with Cadence Design Systems, Inc. in San Jose, CA, which produces software for designing computer chips used in almost all electronic devices (such as computers, phones, cars, planes, etc.). He manages Cadence Global R&D Engineering Infrastructure for software production, which involves tens of thousands of servers on premise and in the cloud. Roughly half of the Cadence Design's revenue is generated in the U.S., but it also has a sizable presence in Asia and Europe.

Bao's thesis research in the group of Professor **Anthony Starace** involved theoretical and computational modeling of intense laser interactions with atoms. In Fall 1995 he began a brief postdoctoral appointment at the Harvard-Smithsonian Institute for Theoretical Atomic and Molecular Physics (ITAMP), where he worked with Professor Roy Glauber (who won the Nobel prize in 2005). In 1996 he joined Quantum Development Corp. in Wilmington, DE, where he applied mathematical optimization procedures to businesses such as NYNEX, Texas Instruments, and Ford. He learned there that optimization is important in everyday life, that spoken English is critical, and that in business teamwork is more important than independent work.

In 1997 Bao moved to Toronto to work for Platform Computing, a privately-held leader in cluster, grid, and cloud management software (that in 2011 was acquired by IBM). Over the next decade he began as a consultant for cluster/grid implementations and then moved to sales in Silicon Valley. While there, he obtained his MBA degree from the University of California-Berkeley during 2003-6, where he learned about innovation and intellectual property management, entrepreneurship, and the business approach for reducing poverty and income inequality. In 2007 he took a position as a Senior IT Architect with Cadence Design Systems and has since then risen in the management ranks and has traveled extensively in Asia.

In 2008 Bao returned to the Department to speak at that year's Recognition Luncheon. He stated then that he felt his education at UNL from 1990-95 was excellent. Not only did he obtain a solid foundation in physics, but also learned skills vital to leadership and that different cultures have different approaches to research.

The Department is very grateful to the following individuals for their new and continuing financial contributions during the period 1 September 2015 - 30 September 2017:

Ahmed, Akhter
Berggren, Matthew M. (B.S. 1997)
Bloom, Kenneth
Boyer, Larry L. (M.S. 1968, Ph.D. 1970)
Caplan, Louis J., Ph.D.
Gray, David M. (B.S. 1977)
Hawthorne, Maurice
He, Ping & Yun Zhang
IBM Corporation - Frances Ruckman
Jacobs, Loyd D. (M.S. 1958)
Keifer, David
Kirby, Roger D. & Suzanne R.
Macek, Ellen M.
Niva, Gordon D. (M.S. 1975, Ph.D. 1979)
Olsen, Suzanne
Pilalis, Labros (B.A. 1978) & Jessica
Rashid, Harunor (Ph.D. 1983)
Ruckman, Jerry E. (B.S. 1962)
Sellmyer, David J.
Skov, Ann
Starace, Anthony F.
Tveten, Alan B. (M.A. 1959)

How to Contribute

If you wish to contribute a tax-deductible gift in support of the Department of Physics and Astronomy, please note that we have the following general accounts at the University of Nebraska Foundation:

1) ***Physics & Astronomy Development Fund*** [for unrestricted funds] (Account No. 2557.0)
2) ***Physics & Astronomy Lecture Endowment Fund*** (Account No. 3321.0)
3) ***Physics & Astronomy Alumni Scholarship Endowment Fund*** (Account No. 3303.0)
4) ***J.E. Ruckman Fund for the Physics Department*** (Account No. 1687.0)

Alternatively, former students, friends, and/or colleagues of Professors Sitaram Jaswal, Ted Jorgensen, Roger Kirby, and David J. Sellmyer as well as of Lecture Demonstrations Manager Menno Fast may wish to contribute to the following endowment funds:
5) ***Banti & Mela Ram Jaswal Fund*** [for undergraduate scholarships] (Account No. 6843.0)
6) ***Ted Jorgensen Fund for Physics*** [for undergraduate scholarships] (Account No. 8846.0)
7) ***David J. & Catherine J. Sellmyer Fund*** [for support of condensed matter and materials science] (Account No. 6781.0)
8) ***Menno Fast Memorial Fund*** [for lecture demonstration equipment] (Account No. 10681.0)
9) ***Roger and Suzanne Kirby Fund*** [for Outstanding Physics Major] (Account No. 112318.0)

Contributions to any of these may be made conveniently using the contribution card and return envelope enclosed with the mailing of this newsletter, or through the NU Foundation website at: http://nufoundation.org.

Checks should be made payable to the University of Nebraska Foundation and should indicate for which account the money is intended. Those contributors whose employers have a matching gift program should indicate this.

The Department's accounts at the University of Nebraska Foundation support purchases of major items of capital equipment, an endowed professorship, graduate fellowships, undergraduate scholarships, invited lectures, and other Department needs.

The Record

Editor: Amanda Lager

DEGREE RECIPIENTS

2015-2016 DEGREE RECIPIENTS

Bachelor of Arts

- **Savanna McDonald** (December 2015)

Bachelor of Science

- **Stuart Brutsche** (December 2015)
- **Samantha Burtwistle** (December 2015) enrolled in the graduate program at Georgia Tech and is currently doing an industry co-op at Kimberly-Clark.
- **Robert Carlson** (December 2015)
- **Shelby Clausen** (May 2016) enrolled in the Masters of Arts with an emphasis in science teaching (MAst) program at UNL.
- **Kevin Hagen** (May 2016)
- **Seth Kurfman** (May 2016) enrolled in the graduate physics program at Ohio State University.
- **Dale Lobb** (May 2016)
- **Andrew O'Connell** (May 2016)
- **Jordan O'Neal** (May 2016) enrolled in the graduate physics program at Stanford University.
- **Celeste Labedz** (August 2016) enrolled in the graduate geophysics program at the California Institute of Technology and received a 2017 National Science Foundation Graduate Research Fellowship.

Master of Science

- **Paulo Costa** (December 2015) entered the doctoral program in physics at UNL working with Professor Enders.
- **Yang Liu** (December 2015)
- **Weiwei Zhao** (May 2016)

Doctor of Philosophy

- **Alexander Stamm** (December 2015) took a Postdoctoral Research Associate position at UNL working with Professor Shadwick.
- **Jingfeng Song** (May 2016) took a Postdoctoral Research Associate position at UNL working with Professor Hong.
- **Jie Yang** (May 2016) took a Research Associate position with SLAC National Accelerator Laboratory.
- **Maria Becker** (August 2016) took a physicist position at the National Institute of Standards and Technology Communications Technology Laboratory in Boulder, CO.
- **Sumit Beniwal** (August 2016) took a Postdoctoral Research Associate position at Erlangen, Germany.

2016-2017 DEGREE RECIPIENTS

Bachelor of Arts

- **Brock Makovicka** (May 2017)
- **Jennifer Hamblin** (August 2017) took a position at UNL working with Professor Dowben.

Bachelor of Science

- **Westin Edrington** (December 2016) took a position with a software company in Indianapolis, Indiana, and enrolled in the online Masters in Business Administration program at UNL.
- **Levi Jaspersen** (May 2017)
- **Ashton Neylon** (May 2017)
- **Zachary Smith** (May 2017)
- **Jack Rodenburg** (August 2017)

Doctor of Philosophy

- **Uday Singh** (December 2016)
- **Xin Zhang** (December 2016) took a permanent staff scientist position with X-Ray Optical Systems.
- **Bhaskar Das** (May 2017) took a Postdoctoral Research Associate position at the Ames Lab Critical Materials Institute, Iowa State University.
- **Keith Foreman** (May 2017) took a Postdoctoral Research Associate position at UNL working with Professor Gay.
- **Iori Tanabe** (May 2017) took a permanent staff scientist position with National Instruments.
- **Xiaoqian Dang** (August 2017)
- **Yunlong Jin** (August 2017) took a Postdoctoral Research Associate position at UNL working with Professor Sellmyer.
- **Nathan Clayburn** (August 2017)
- **Elena Echeverria Mora** (August 2017)
- **Junlei Wang** (August 2017)

FELLOWSHIPS & TRAINEESHIPS

2015-2016 FELLOWSHIPS & TRAINEESHIPS

Chancellor's Fellowship
Karl Ahrendsen

GAANN Fellowship
Giovanni Baez Flores
Colton Fruhling
Corbyn Mellinger
Noah Sutton

NASA Nebraska Space Grant
Jonathan Reyes
Alexander Stamm
Nicole Benker
Shelby Clausen
Jennifer Hamblin
Matthew Hormandl
Celeste Labedz
Savanna McDonald

Othmer Fellowship
Paulo Costa
Elena Krivyakina

Bridging Program Fellowship
Prescott Evans
Travis Hutchins
Christopher Keck
Ross Kuchta
Corbyn Mellinger
Yu Hang Ng
Shane Sandhoefner

NCMN Graduate Research Fellowship
Ivan Zhuravlev

2015 AVS Graduate Research Award
Elena Maria Echeverria Mora

2016 INTERMAG Best Student Presentation Award
Anil Rajapitamahuni

Undergraduate Teaching Assistant Fellowships
Roshan Bengali
Nicole Benker
Samantha Burtwistle
Robert Carlson
Shelby Clausen
Austin Connor
Zebulon Cooper
Ellie Feis
Jennifer Hamblin
Matthew Hormandl
Seth Kurfman
Savanna McDonald
Ashton Neylon
Andrew O'Connell
Hannah Paxton
Emma Schneider
Molly Seeger
Zachary Smith

SRC STARnet Undergraduate Research Internship
Ethiyal Wilson
Jack Rodenburg

Darrell J. Nelson Summer Undergraduate Internship in Energy Sciences Research
Ethiyal Wilson

Finalist, ND Connect Competition
Ethiyal Wilson

Silicon Lab Research Recognition Award
Kevin Hagen

2016-2017 FELLOWSHIPS & TRAINEESHIPS

Bridging Program Fellowship
Thomas Feigenson
Bret Gergely
Simeon Gilbert
Roland Hesse
Luis Jauregui
Kyle Jensen
Emily Kaplan

Fulbright Scholarship
Björn Senfftleben

GAANN Fellowship
Colton Fruhling
Corbyn Mellinger

Jorgensen Fellowship
Roland Hesse

MRSEC Fellowship
Luis Jauregui

Othmer Fellowship
Yanwei Xiong

Undergraduate Teaching Assistant Fellowships
Roshan Bengali
Shelby Clausen
Ellie Feis
Jennifer Hamblin
Alexzai Lundberg
Ashton Neylon
Hannah Paxton
Zachary Rohde
Sophie Sealer
Zachary Smith

Spring 2017 College of Arts and Sciences Poster Award
Roshan Bengali

UNL Spring Research, Exploration and Discovery Talk
Spencer Prockish

NASA Nebraska Space Grant
Nicole Benker
Shelby Clausen
Zachary Smith

UNL High Scholars
Matthew Dunn
Rebecca Fitzgarrald
Ethan Gubbels
Micah Holmes
Peter Kosch
Jesse Kruse
Aashish Subedi
Jacob Twibell

SCHOLARSHIPS

2015-2016 SCHOLARSHIPS

John E. Almy
Austin Buchanan
Robert Carlson
Alexander Johnson

Dr. William L. Bade
Shelby Clausen
Michael Pieper
Zachary Smith

R.M., S.M., and A.M. Eddy
Nathan Ghanavati

Ed Hirsch
Zachary Smith
Celeste Labedz

Banti & Mela Ram Jaswal
Alexander Johnson
Andrew O'Connell
Westin Edrington

Cheunjit Katkanant Memorial
Westin Edrington

Henry H. Marvin
Ashton Neylon
Gabriel Gauthier
Matthew Dunn

Shelby Clausen

Kurt Meyer Physics
Nathan Ghanavati

Joel Stebbins Fund
Samantha Burtwistle
Westin Edrington

Physics & Astronomy Scholarship Endowment
Celeste Labedz
Ben Sukup
Jordan O'Neal
Jack Rodenburg
Austin Buchanan

2016-2017 SCHOLARSHIPS

John E. Almy
John Chrostek
Michael Kasada

Dr. William L. Bade
Ashton Neylon
Zachary Smith

Banti & Mela Ram Jaswal
Ashton Neylon

Henry H. Marvin
Matthew Dunn
Michael Kasada
Peter Kosch

Kurt Meyer Physics
Zachary Smith

Joel Stebbins Fund
Amber Bridgeford
Matthew Dunn

Physics & Astronomy Scholarship Endowment
Amber Bridgeford
Ashton Neylon
Michael Pieper

HONORS

2015-2016 HONORS

Elected to Board of Directors of the American Physical Society
Timothy Gay

Fellow of the American Physical Society
Dan Claes

Fellow of the Royal Society of Chemistry
Peter Dowben

DOE Early Career Grant
Alexey Kovalev

NSF CAREER Award
Xiaoshan Xu

Certificate of Recognition for Contributions to Students, UNL Parents Association and Teaching Council
Matthias Fuchs
Orhan Yenen (received for 5th time)

2015 Nebraska Lecture, the Chancellors Distinguished Lecture Series
Dan Claes

NCMN Ambassador Award
Shireen Adenwalla

2015-2016 Society of Physics Students Officers
Celeste Labedz
Seth Kurfman
Davis Rempe
Spencer Prockish

Outstanding Graduate Teaching Assistant Award
Joaquin Siado-Castaneda

Outstanding Undergraduate Teaching Assistant Award
Roshan Bengali

Undergraduate Award for Excellence in Research
Benjamin Bradley

Undergraduate Merit Award for Academic Performance
Matthew Dunn

UCARE Award Recipients
Peter Kosch
Jordan O'Neal
Austin Schulte
Zachary Smith

Roger & Suzanne Kirby Outstanding Physics Major Award
Seth Kurfman

2016-2017 HONORS

Elected Chair of US CMS Collaboration Board
Gregory Snow

International Fellow of the Japan Society of Applied Physics
Alexei Gruverman

US Department of Energy Early Career Award
Xia Hong

Certificate of Recognition, Parents Association and Teaching Council
Matthias Fuchs (second award)

Willa Cather Professor
Timothy Gay

Susan J. Rosowski Associate Professor
Martin Centurion

FAST Fellow, Departments of Physics and Chemistry, ETH-Zürich
Anthony Starace

NCMN Education Outreach Service Recognition
Shireen Adenwalla
Christian Binek
Stephen Ducharme
Xia Hong
Xiaoshan Xu

2016-2017 Society of Physics Students Officers
Matthew Dunn
Spencer Prockish
Roshan Bengali
Caleb Schmidt
Nicole Benker

Outstanding Graduate Teaching Assistant Award
Corbyn Mellinger

Outstanding Undergraduate Teaching Assistant Award
Zachary Smith

Undergraduate Award for Excellence in Research
Andrew Shultz

Undergraduate Merit Award for Academic Performance
Matthew Dunn

UCARE Award Recipients
Roshan Bengali
Alex Clough
Ankit Pant
Spencer Prockish
Andrew Shultz

Roger & Suzanne Kirby Outstanding Physics Major Award
Matthew Dunn

COLLOQUIA

2015 FALL SEMESTER COLLOQUIA

September 24
Hanan Dery, University of Rochester
"Spin transport in 2D crystals and in elemental semiconductors with multivalley band structure"

October 15
Flera Rizatdinova, Oklahoma State University
"High Energy Physics at the Large Hadron Collider and the ATLAS Experiment"

November 5
Benjamin Stieger, University of Nebraska-Lincoln
"Measuring the mass of the top quark"

November 12
David A. Reis, Stanford PULSE Institute
"Ultrafast Lattice Dynamics"

December 3
Bret Flanders, Kansas State University
"Materials at the nanoscale: from nanowires to biological cells"

2016 SPRING SEMESTER COLLOQUIA

January 28
Evgeny Tsymbal, University of Nebraska-Lincoln
"Spintronics with Ferroelectrics"

February 11
Jeremy Levy, University of Pittsburgh
"Etch-a-Sketch Nanoelectronics"

February 25
Igor A. Lukyanchuk, Laboratory of Condensed Matter Physics, University of Picardie
"Resonance Terahertz Electrodynamics of Domain Walls in Thin Ferroelectric Films: Effect of Negative Capacitance"

March 10
Jian Wang, Peking University
"Observation of quantum Griffiths singularity in 2D superconductors and detection of potential topological superconductivity in 3D Dirac semimetal"

April 14
Charles Ahn, Yale University
"The materials physics of complex oxides"

May 9
Mark van Schilfgaarde, King's College London
"A Framework for Correlated Electrons in Solids"

2016 FALL SEMESTER COLLOQUIA

September 22
Bruno deHarak, Illinois Wesleyan University
"Some photons, an electron, and an atom"

October 6
Nathaniel Cunningham, Nebraska Wesleyan University
"The success of New Horizons: NASA's first mission to Pluto"

October 27
Anne Marie March, Argonne National Laboratory
"X-ray snapshots of molecules in motion"

November 3
Ruihua Cheng, Indiana University-Purdue University
"Fabrication and Characterization of Magnetic Heteronanostructures – Knowing the world at the nanoscale"

November 10
Min Chen, Shanghai Jiao Tong University
"From laser plasma wakefield acceleration to table top radiation source"

November 17
Dr. Samindranath Mitra, Editor, Physical Review Letters
"Physics after the lab and the desk: Your work in Physical Review Letters"

December 1
Klaus Bartschat, Drake University
"Electron Collisions – Experiment, Theory, and Applications"

2017 SPRING SEMESTER COLLOQUIA

January 11
Philip Nicholson, Cornell University
"Saturn's Rings and Icy Moons from Cassini"

January 26
Jian Wang, University of Nebraska–Lincoln
"Achieving Atomic-level Design of Structures and Properties of Materials by Tailoring Interfaces in Solids"

February 9
Peter Sutter, University of Nebraska–Lincoln
"2D Materials: From Macroscopic Perfection to Emerging Nanoscale Functionality"

University of Nebraska Lincoln
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