Summer 2020

CrossSections, Summer 2020

University of Northern Iowa. Department of Physics.

CROSSSECTIONS

SUMMER 2020

A MESSAGE FROM THE DEPARTMENT HEAD, DR. PAUL SHAND

Dr. Paul Shand
Professor and Head of the
UNI Department of Physics

Dear Friends,

This issue of Cross Sections comes to you in the midst of the novel Coronavirus pandemic. I am sure all of you have experienced various levels of disruption because of the virus. We are no exception. As you know, colleges and universities (including UNI) switched to online instruction after spring break, with only a week of preparation. It took an immense amount of effort to make that sharp transition successfully; however, it is now obvious that making that transition is child's play compared to what needs to be done to have in-person classes in the fall. UNI is now fully engaged in planning for the reopening of the campus to students in the fall. It is certainly fortunate that we have the summer period to develop, refine and implement action plans to deal with this complex problem. Of course, each of you is coping with your own version of this problem. I certainly wish you all the best as the nation tries to reopen for business under the continued threat of the virus. Let me now apprise you of some of the other significant events on campus and in the Physics Department over the past year.

I mentioned last year that the General Education program (now called the Liberal Arts Core) at UNI is undergoing a major revision. That process is now much closer to its conclusion. Twelve student outcomes and a three-layered structure have been approved by the University Faculty Senate. Also, the total number of credit hours has been set at 37, significantly lower than the current 45. While the outcomes-based structure of the program is laudable, a notable drawback is that the science requirement can be satisfied by a single lab course – life science or physical science. This change will likely result in lower enrollments in our Physics in Everyday Life (PEL) course. However, collaboration between disciplines is encouraged; thus, I anticipate that PEL will undergo its own redesign soon.

The UNI Foundation is in the early stages of its newest capital campaign, which is its biggest fundraising effort to date. The capital campaign is a multiyear affair, usually centered on a particular theme and tagline (e.g., "Students First"). The official launch is about a year away, but fundraising for the campaign has already begun. The goal is $250 million. Over the next few years, events surrounding the campaign will likely dovetail with those accompanying the celebration of UNI's sesquicentenary – the 150th year of existence of this great institution.

At the departmental level, we've had quite a successful year. Senior physics major Joseph Tibbs, who won a Goldwater scholarship last year, has been collecting even more honors and awards. During the spring semester, we learned that Joseph was the winner of a National Science Foundation Graduate Research Fellowship, which is a highly competitive fellowship program for new graduate students. Later in the spring, Joseph was notified that he had received a McElroy fellowship, which provides a total of $36,000 for three years to a student pursuing a Ph.D. in the sciences or engineering. Joseph will be pursuing a Ph.D. in bioenegineering at the University of Illinois Urbana-Champaign in the fall.

(Continued on next page)

University of Northern Iowa

A NEWSLETTER FOR ALUMNI AND FRIENDS OF THE
DEPARTMENT OF PHYSICS, UNIVERSITY OF NORTHERN IOWA

A team led by physics faculty members Tim Kidd and Andy Stollenwerk was awarded a $328,000 grant by the U.S. Department of Energy. The objective of the three-year project is to investigate quantized growth modes of noble-metal films on layered materials such as molybdenum disulfide (MoS_2). Stollenwerk and Kidd discovered these growth modes with the help of Stollenwerk's scanning tunneling microscope. Several physics majors have had the opportunity to participate in this exciting research and many more will be supported by this grant.

Richard Jourdan, grandson of Louis Begeman, after whom the Physics Building is named, has created the Jourdan Scholar-Mentor Endowed Award, which provides scholarships to two first-year physics majors and an upper-class physics major who serves as a mentor. The endowment allows these scholarships to be awarded to our students in perpetuity. We are extremely grateful to Richard for his immense generosity and continued interest in the welfare and success of our majors.

Most of you know Becky Adams, who has been our Department Secretary for 30 years. Becky will retire on July 1. She has been a pillar of the department for a generation; her professionalism and personableness can never be replaced. Someone else will take over her duties and departmental administration will continue, but it will not be the same. We will miss Becky greatly. Later in this issue, Becky shares her thoughts about her time in the Physics Department. Please join me in wishing Becky a happy retirement.

I will end this message by expressing my thanks for your continued support through donations and attendance of our events. I am especially grateful for the strong support for new students and undergraduate research. It is my fervent hope that all of you remain in good health and that by next year when we use this medium to communicate, we have all been effectively vaccinated against COVID-19. Please take care, and thanks again for your support.

CONTENTS

Faculty Profile — *3*
Pavel Lukashev

Department Happenings — *4*

Focus on Students — *9*

Physics Education — *14*

Alumni Profile — *15*
Wes Golden

Alumni News — *16*

Retrospective — *17*

New Physics — *18*

Support the Department — *19*

FACULTY PROFILE

Pavel Lukashev
Assistant Professor of Physics

Dr. Pavel Lukashev hails from Yerevan, Armenia. He is the holder of bachelor's and master's degrees in physics, a master's in industrial engineering and systems management, and a Ph.D. in physics. His doctoral work was done at Case Western Reserve University in Cleveland, Ohio.

Dr. Lukashev's interest in physics developed less like a lightning strike, and more like the aging of wine. "It was a gradual process," he says. "My interest in physics developed with time, as I studied in college, read professional literature, and interacted with academic and research advisors and colleagues. In general, career choices are rarely influenced by a single event."

Lukashev came to UNI in August 2014 as an assistant professor of physics. He was excited to become a faculty member at UNI because of the impressive facilities and the vibrant research atmosphere. "In particular, at the time I moved to UNI, four of the Physics faculty members were performing research in condensed-matter physics and materials science, which is my own field of expertise," Lukashev enthuses. "In addition, the Department of Physics owned (and still owns) a computer cluster, which I needed for my own research." In addition to the research environment, Lukashev was also drawn to the "Goldilocks" size of the university (not too big, not too small), the friendly faculty and staff, the beauty of the campus, and UNI's geographic location. He had previously spent several years as a postdoctoral researcher at the University of Nebraska-Lincoln and was happy to be within a few hours' drive of Lincoln. At UNI, Lukashev has taught both introductory physics courses (General Physics I and II and advanced undergraduate courses (Thermodynamics and Statistical Mechanics, Electrodynamics, and Optical Science).

The recent, sudden transition to online instruction due to the pandemic actually turned out to be an interesting experience for him. "As a result of this transition, I developed a set of online labs (based on available online simulations) that we conducted with my General Physics I class over Zoom," he states. "Students worked in groups (breakout rooms) on a lab activity by sharing the screen with each other, and working together on the lab report using Google Docs. In my opinion, this went surprisingly smooth and well, given the circumstances."

Dr. Lukashev's research is in the area of computational materials science, with a focus on the investigation of magnetic properties of materials. In the last few years, he has studied mostly materials known as half-metals. A material is an electric conductor if an electric current is established when an external electric field is applied. An electric insulator does not conduct electric current. Each electron has an intrinsic property called spin, which can only take two values, often called spin-up and spin-down. A half-metal is a material that is an electric conductor for one spin value, and an insulator for the other. Half-metals are in high demand in the emerging field of spin-based electronics, known as spintronics. One practical application of this new field is data storage, e.g., in computer random access memories.

Lukashev has actively involved students in his research at UNI. His students have been co-authors of 14 peer-reviewed journal articles so far. Dr. Lukashev has received many grants to support his research. He's a co-Principal Investigator (with Tim Kidd, Andy Stollenwerk and others) of a recently awarded U.S. Department of Energy (DOE) grant to study quantized growth modes of noble metals on layered crystalline materials. He's also the recipient of a sub-award for another DOE grant (external to UNI) to study the production of spin-polarized electrons in hybrid half-metal nanostructures. Both projects are keeping Dr. Lukashev very busy this summer.

Dr. Lukashev has been involved in numerous service activities at UNI, including service at the departmental, college and university levels. He has also contributed significantly to serving the physics profession. He has reviewed numerous manuscripts submitted to an astonishing array of journals, including the prestigious *Physical Review Letters*. He received an Outstanding Reviewer award from the publishers of the *Journal of Physics: Condensed Matter* in 2019.

What does Dr. Lukashev do for fun? "When I have free time, I like reading biographies, science-history books, novels, crime fiction, watching movies, playing chess, traveling, and cooking," he says."I have a slight preference for Mediterranean food, but otherwise I enjoy many types of cuisines." Truly a man for all seasonings.

DEPARTMENT HAPPENINGS

Upward Bound Camp

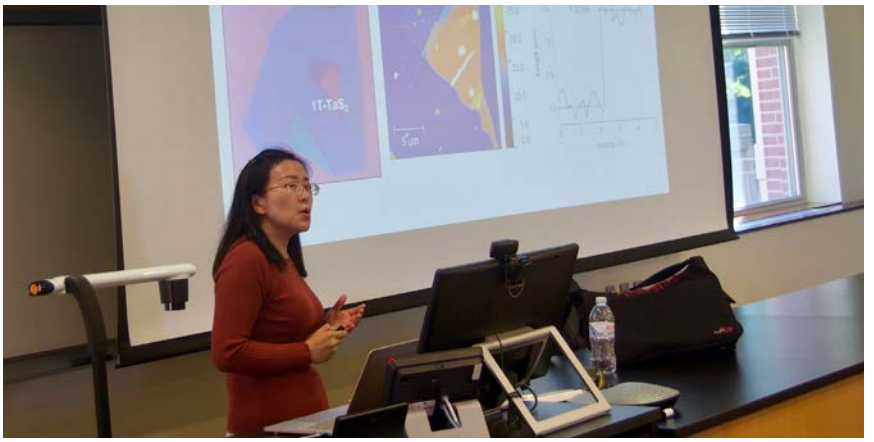
Last summer, the Physics Department hosted a five-week long robotics camp for Upward Bound students. Upward Bound is a federally-funded program for low-income, first-generation high school students. UNI has been a long running Upward Bound site and though the department has previously engaged with Upward Bound students, the robotics camp was a new undertaking. Faculty member Tim Kidd directed the camp and he was assisted by physics major Tyler Brown.

Tyler Brown (center) talks with students at Upward Bound robotics camp.

Upward Bound students show off their robots.

Rui He Colloquium

Former UNI Physics faculty member Rui He (now at Texas Tech University) returned to UNI to give a colloquium on August 28. The title of Rui's talk was "Raman Spectroscopy of 2D Materials." Rui's recent work includes investigations of the nature of magnetic states in the new 2D ferromagnet chromium triiodide (CrI_3).



Rui He discusses the physics of two-dimensional materials during her talk.

Physics Club picnic attendees in the Begeman Hall courtyard.

Physics Club Picnic

The annual Physics Club picnic was held in the Begeman Hall courtyard on September 13. Food, fun, and fellowship were in abundance at the event. In addition to UNI Physics students, faculty and staff, representatives from Coe College's Society of Physics Students (SPS) chapter were also present.

Chef Tyler Nelsen at the grill.

DEPARTMENT HAPPENINGS

Homecoming Picnic

Our annual Homecoming picnic was held on Saturday, October 5. For the third time in as many years, the event was forced indoors to 114 Begeman Hall because of the weather (heavy rain). As usual, the weather did not put a damper on the gathering, which was quite large despite the sogginess outside. The food was wonderful and the conversation enthralling. We hope for sunny weather next time!

Some of the Homecoming picnic attendees inside 114 Begeman Hall.

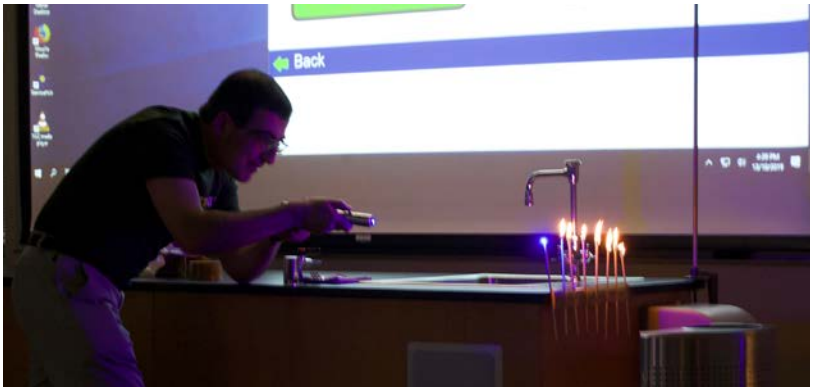
Paul Shand and Chad Hade at the Maucker Union during Alumni in Residence Day.

Michelle Wei, Steve Guyer and Paul Shand do some catching up.

Alumni in Residence

Alumni in Residence Day for 2019 was Thursday, October 17. Our Alumnus in Residence was Chad Hade. Chad received a B.A. in Physics in 1997 and an M.B.A. in finance from UNI in 1999. Since receiving his degrees from UNI, Chad has worked in corporate finance, specializing in real estate loans and investment. He is currently director of debt placement for Life Care Services in Des Moines. Chad is also a member of the advisory board for UNI's Real Estate program. Chad and his family live in the Des Moines area.

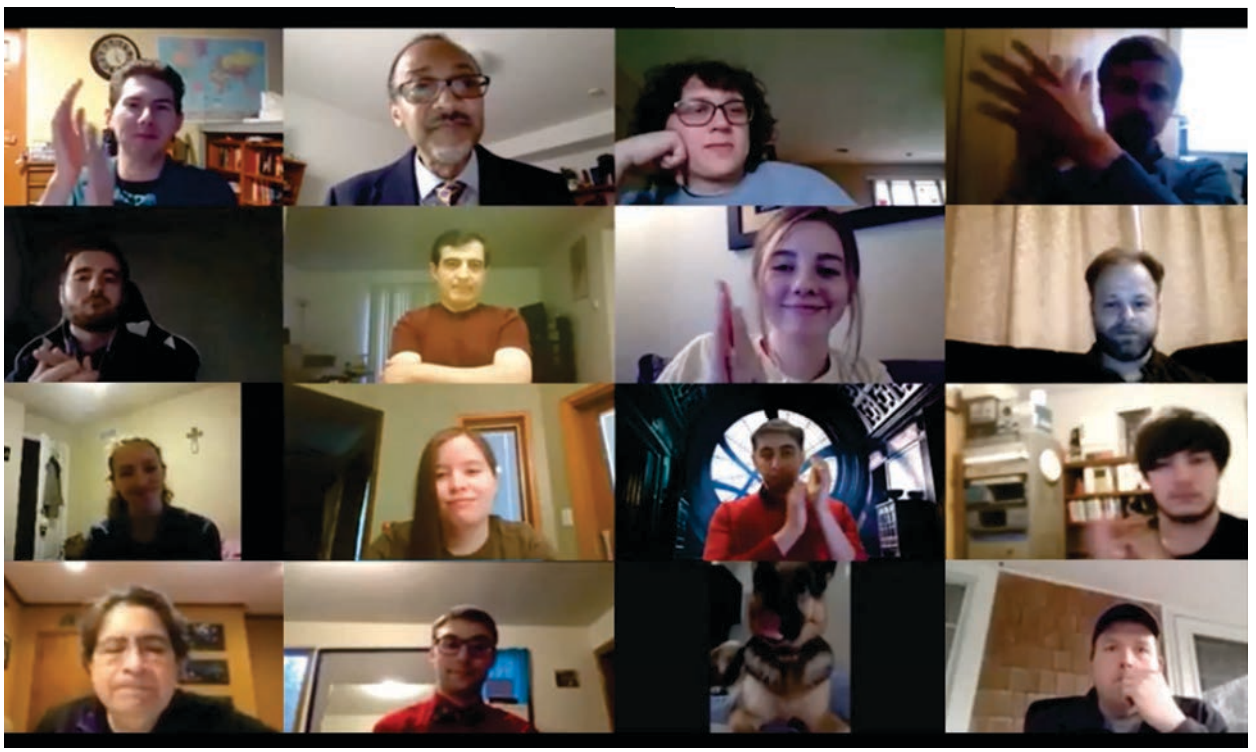
Physics major Erica Oler demonstrates her juggling skills.



Faculty member Pavel Lukashev lights matches with a powerful blue laser.

Holiday Colloquium

The annual Holiday Colloquium is held at the end of the fall semester to express our gratitude to the staff (Department Secretary, Technician, Custodian, and their student assistants) for their great work throughout the year. In addition to food (yes, there is always food), everyone is encouraged to do demonstrations that fall into three categories: plain demos; magic tricks; and minor miracles. The Holiday Colloquium is always a fabulous way to end the year and celebrate the holidays.



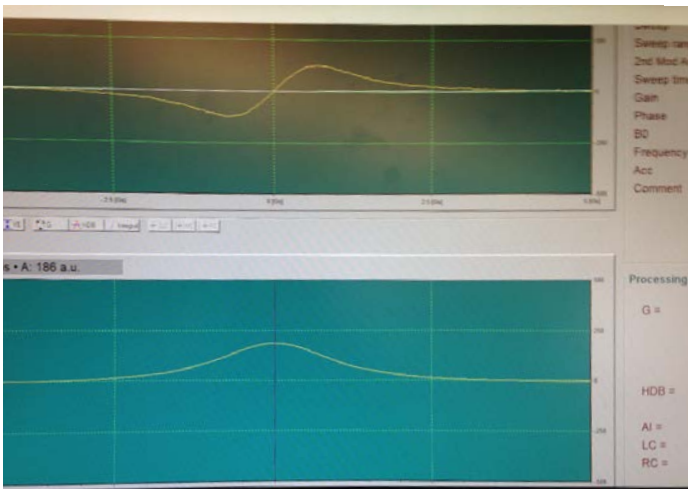
Virtual Awards Ceremony

Because of the COVID-19 pandemic, several spring events were canceled, including our annual awards banquet. To ensure that students were publicly congratulated for their academic and service-related achievements, the Physics Department hosted a Virtual Awards Ceremony via Zoom on May 7. Though the virtual event had obvious disadvantages (e.g., no food), it was still an enjoyable event for all participants, including pets.

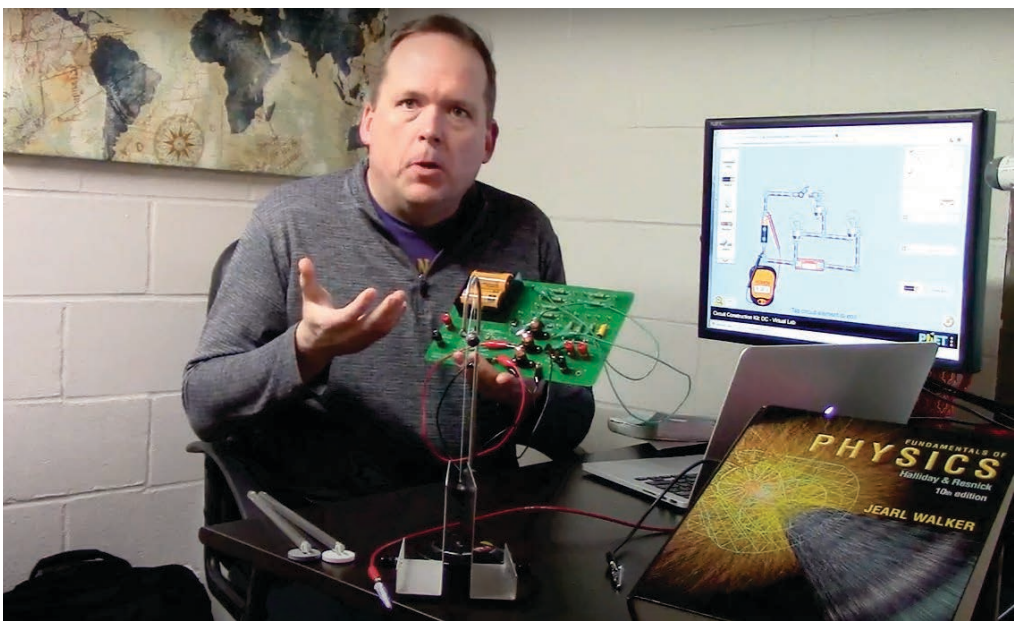
DEPARTMENT HAPPENINGS

Online Instruction

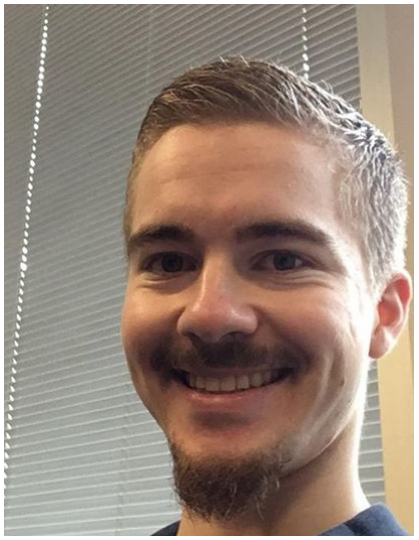
The Coronavirus pandemic forced universities to abandon face-to-face classes and rapidly switch to online instruction in March. Several Physics faculty members had already taught online courses before the switch; thus, the transition was not as fraught as it could have been. Necessary equipment was borrowed for use at home. The simulations used to substitute for labs were both a blessing (no frustration with equipment) and a curse (no frustration with equipment).



A snapshot of the derivative and absorption graphs for electron paramagnetic resonance in the Modern Physics Lab course. Snapshots, video, and data were sent to students.



Jeff Morgan illustrates an electric circuit for his Physics II class conducted online from his basement.



Ryan Carlile

Ryan Carlile is a physics and philosophy double major who was born in Cedar Rapids, Iowa. He was home-schooled through the Marion Homeschool Assistance Program. Carlile picked UNI for his undergraduate education for two main reasons. "It was affordable, and I already had some friends here, which made it much easier to get involved in the community and figure out off-campus living situations," he explains.

Attending UNI has been an enjoyable experience for Carlile. "It's been often said, but it bears repeating: UNI has a fantastic community," he enthuses. "I've gotten to know many wonderful people during my time here, and I've made memories with them that will last a lifetime. I can honestly say that one of the toughest parts of the whole COVID-19 situation has been not being able to spend time with them or say goodbye after graduation. Still, I look forward to seeing where life takes them, and I'm grateful for the time I did get, short as it was."

Carlile's reasons for choosing to major in physics are rather interesting. "One reason I chose physics was because I knew it would be difficult for me and force me to grow," he says. "Prior to attending UNI, I had no special interest in the sciences and a somewhat cold relationship with math. My background in both subjects was limited."

Carlile expanded on this: "Take my physics experience, for example. Aside from an algebra-based textbook I studied in high school and the bits and pieces of knowledge you collect unconsciously from popular culture, I hardly knew anything about it, and my knowledge of mathematics was not in much better shape. For that reason, the first couple of semesters of this major were tough for me, but I can honestly say that I'm glad I stuck it out. Difficult things make you grow, and physics has been no exception." Well, that's one reason for choosing physics. Was there another? "Okay, I'll be honest. I also chose physics because I hoped it would help me get a decent job after I graduated. There, I said it. Mercenary, I know, but sometimes you gotta do what you gotta do."

> "Difficult things make you grow, and physics has been no exception."

As a B.S. Physics major, Carlile was required to complete an undergraduate research project. "I conducted undergraduate research under the supervision of Dr. Pavel Lukashev," he states. "To make a very complicated story as simple as possible, I mainly studied two materials—thin-film palladium and thin-film Co_2CrAl—using computational methods." His goals were twofold: first, determine whether there is any relationship between palladium's allowed energy states and the way palladium accumulates in deposition experiments; and second, determine whether Co_2CrAl remains half-metallic when it gets stretched and compressed. (A half-metal is just a metal that only conducts electrons with a certain spin orientation.) Preliminary results showed that palladium did exhibit such a relationship, and that Co_2CrAl remains half-metallic when it gets compressed but not when it gets stretched. At the end of his summer research period, Carlile presented these results at the Summer Undergraduate Research Symposium. He also presented his work at a Physics Colloquium last fall.

As mentioned above, Carlile is also a philosophy major. He has certainly stretched his mind at UNI! When not studying physics or philosophy, he has engaged in many activities at UNI. "I attended events at St. Stephen's Catholic Student Center and played piano for their masses," he states. "For one semester, I worked on the Lang Hall/Maucker Union tech crew and got to run lights and sound for various on-campus events (including Dance Marathon one year), and I spent a number of semesters tutoring student athletes in various subjects."

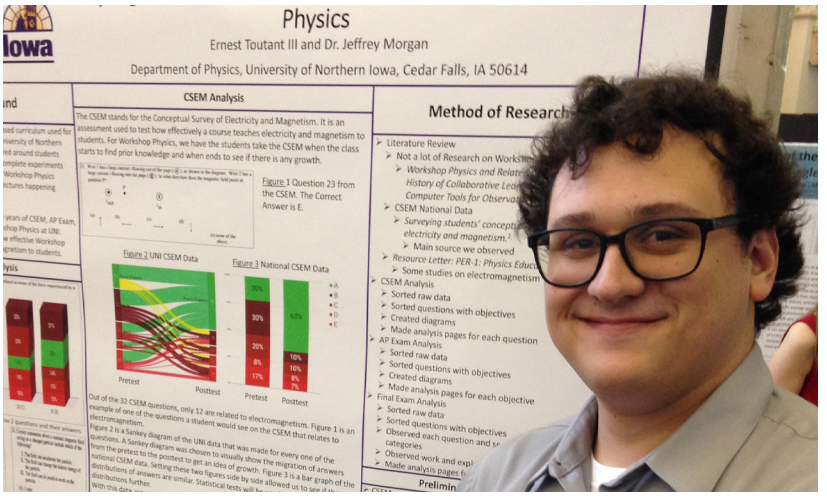
In his free time, Carlile indulges in music and literature. "I'm a pianist of 15-ish years and I love to play whenever I get the chance from time to time," he reports. "I also write and read, though these days it takes a very good book to grab my attention. I'm a huge fan of movies, video games, and board games (yes, I'm a bit of a nerd), and lately, thanks in large part to my studies in physics, I've been working on some of my own coding projects."

Carlile graduated in May and is currently searching for a job that will hopefully take advantage of his cognitive breadth.

FOCUS ON STUDENTS

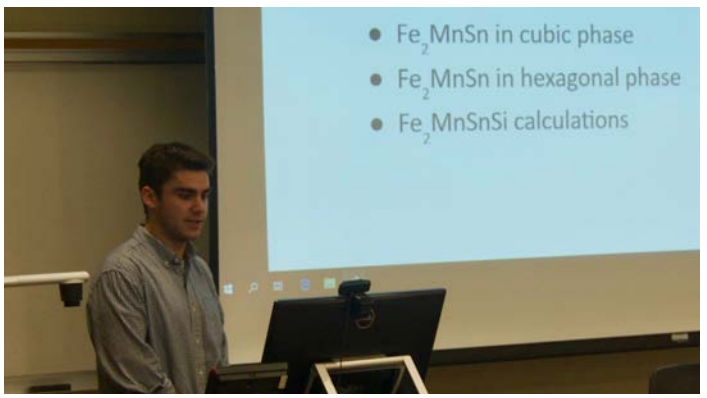
Student Research

Fifteen students received summer undergraduate research fellowships – a very large number. Every faculty member supervised at least one student. Three students undertook science-education research projects, which is also an unusually large number. The students presented their results at the annual Summer Undergraduate Research Symposium held on campus at the end of the summer period and at departmental colloquia in the fall.

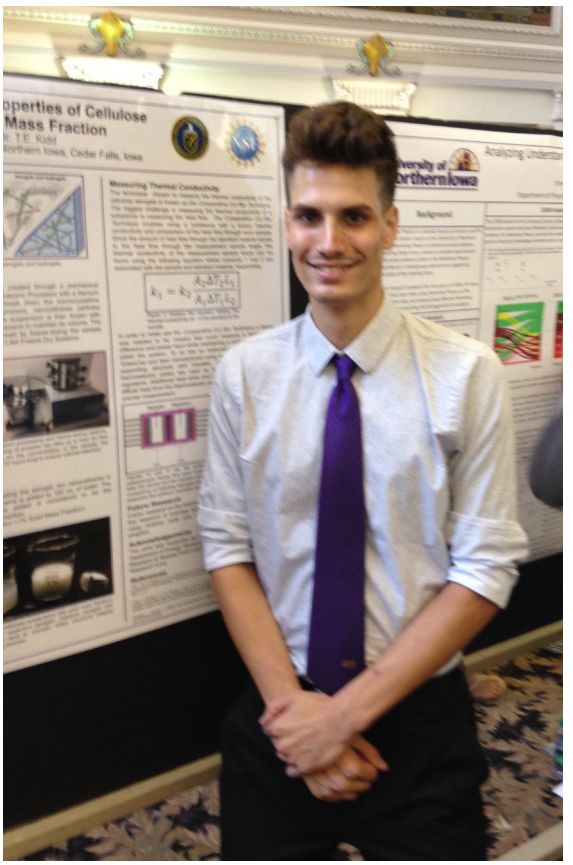


Ernest Toutant III at the 2019 Summer Undergraduate Research Symposium.

Juliana Huegerich explains her research.



Sam Prophet gives the outline for his talk



Dexter Cox and his poster at the 2019 Summer Undergraduate Research Symposium.

Ernest Toutant III

What do students learn (and not learn) when studying physics? This broad question drives the field of physics education research, and formed the basis for a recent research project in the Physics Department.

During the summer and fall of 2019, B.A. Physics Teaching major Ernest Toutant III and Associate Professor Jeff Morgan engaged in a research project examining student learning of electromagnetic concepts in introductory physics.

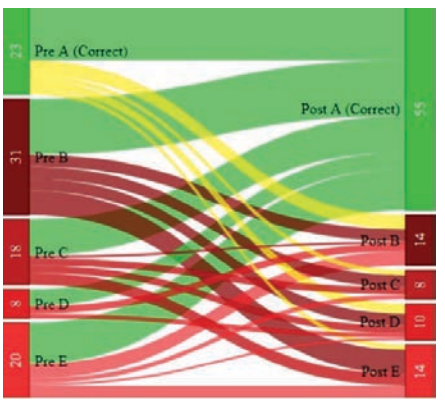
Since 2010, Morgan has been using Workshop Physics, an interactive laboratory-based curriculum, for the calculus-based Physics for Science and Engineering courses. The program was developed by Priscilla Laws and colleagues at Dickinson college; UNI faculty attended a workshop explaining the program in the mid 1990s. The workshop approach replaces traditional lectures and weekly laboratory sessions with three two-hour interactive periods each week, integrating small group experimentation with discussion and problem solving. Optional lectures are recorded and available for students to watch outside of regular class time. Toutant took the courses his first year at UNI, served as a learning assistant for the course the following year, and finally selected the course as a focus for research.

Following discussion with Morgan, Toutant selected electromagnetism as the focus for the project. Electromagnetic phenomena, including the concept of a magnetic field, observing and calculating the Lorentz force, examining Faraday's law, finding the e/m ratio, and transmitting power wirelessly, are found within the final two units students study during the spring semester. These topics are historically challenging for most students, likely due to their abstract nature, mathematical complexity, and perhaps the fact that they are studied at the end of the academic year. Toutant was interested in finding out whether or not the evidence suggested that the Workshop Physics learning objectives for each unit were being met, and how UNI students' learning compared to students at other institutions.

After reviewing the literature and finding few studies on student learning in either the Workshop Physics program or electromagnetism, Toutant turned his attention to the available evidence of student learning from our introductory course. The department administers a previous AP C physics test each semester as part of program assessment. Additionally, Morgan uses the Conceptual Survey on Electricity and Magnetism (CSEM), developed by Maloney, et. al., as a pretest and posttest to determine conceptual growth. The course also includes three exams throughout the semester to assess laboratory skills and problem-solving abilities. Toutant identified questions on all three types of assessments that relate to the electromagnetism objectives in Workshop Physics, then analyzed results from that set of questions from nine years of data.

The CSEM literature published results from nationwide use which included pretest and posttest administration. Toutant constructed Sankey diagrams illustrating the flow of responses from pretest to posttest, then compared UNI student results to national numbers. While in general performance from UNI students did not exceed that of peers at other institutions, they generally matched other students in growth of correct responses within statistical significance.

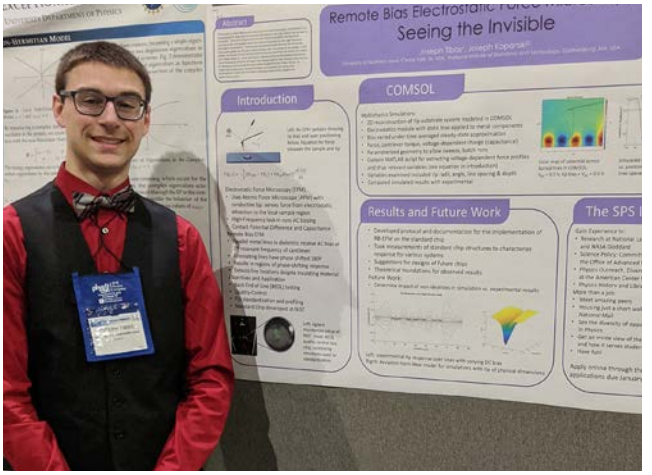
Toutant's research found that students generally performed well on questions testing student understanding of concepts directly addressed within the Workshop Physics units, but less so when a question required combining multiple concepts (such as finding a magnetic field due to a current-carrying wire, then using that field to find a force on a moving charge or a second wire). From the limited evidence of this study, UNI students using Workshop Physics seem to be learning electromagnetic concepts at comparable rates to other students, but not better as often claimed in other physics education studies. Morgan plans to use Toutant's findings to inform small changes to the course, such as assigning more homework problems that require integration of multiple concepts, and see if these adjustments can produce increased learning gains.



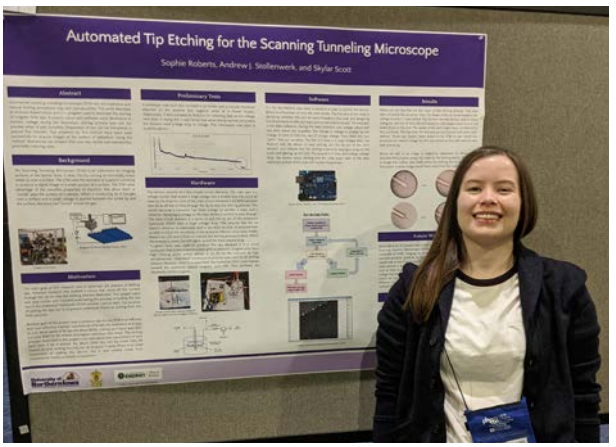
A question from the Conceptual Survey of Electricity and Magnetism. The Sankey diagram above illustrates the flow of student responses from pretest to posttest.

Physics Club PhysCon Trip

PhysCon is a quadrennial international meeting for undergraduate physics students organized by the Society of Physics Students. It is a recurring Woodstock for physics majors. The UNI Physics Department was represented at PhysCon 2019 (held in November) by a rather large group of five physics majors: Taylor Harris, Adam Ramker, Sophie Roberts, Joseph Tibbs, and Gaoyong Wu, who presented posters on their research and participated in many other exciting activities. PhysCon 2019 was held in Providence, Rhode Island.



Tibbs and his poster at PhysCon 2019.



Sophie Roberts at PhysCon 2019.

NSF GRF award and McElroy Scholarship

Joseph Tibbs's illustrious undergraduate career at UNI came to an end this spring. We reported in last year's issue of Cross Sections that Joseph had been awarded a prestigious Goldwater Scholarship. He has since collected more honors, including a National Science Foundation Graduate Research Fellowship and a McElroy scholarship. Joseph will begin graduate studies in bioengineering at the University of Illinois Urbana-Champaign in the fall.

UNI Physics group at PhysCon 2019. From left to right are: Gaoyong Wu, Sophie Roberts, Taylor Harris, Joseph Tibbs, and Adam Ramker.

PHYSICS SCHOLARSHIPS AND AWARDS

Outstanding Performance in Introductory Physics
Madelyn Johnson
Sydney Schmidt

First Year Projects in Physics Award
Madelyn Johnson

Begeman Fund for Excellence in Physics Scholarship
Carter Bush
Jeffrey Carlson
Lauren Hanssen
Ashley Harrington

C. Clifton Chancey Scholarship in Physics
Troy Buzynski

Jourdan Mentor Scholarship
Sophie Roberts

Outstanding Research Presentation
Mary Sutton

Physics Department Service Award
Juliana Huegerich
Tyler Nelsen

Prospective Physics Teaching Award
Ernest Toutant III

Louis Begeman Memorial Scholarships
Taylor Harris
Aaron Kirchman
Sophie Roberts

Grossman-Perrine Scholarship
Juliana Huegerich

Physics Summer 2019 Undergraduate Research Fellowships

Dylan Blattner
Sam Prophet
Tyler Brown
Adam Ramker
Ryan Carlile
Sophie Roberts
Nathan Schmidt
Dexter Cox
Cole Schreiber
Taylor Harris
Skylar Scott
Juliana Huegerich
Mary Sutton
Gaoyong Wu
Ernest Toutant III

Physics Summer 2020 Undergraduate Research Fellowships

Aaron Janaszak
Troy Buzynski
Lukas Stuelke
Aaron Kirchman
Devon Vanbrogen
Adam Ramker
Tyler Brown
Sophie Roberts
Paul White
Nathan Schmidt

UNI Offers Online Physics Teaching Endorsement Program

The Next Generation Science Standards (NGSS) were adopted by Iowa several years ago, and full implementation of the standards within K-12 classrooms is expected beginning this fall. The standards include physical science standards for elementary, middle and high school levels that require students to study physics or physics-focused physical science at each level. At the same time, previous department research has revealed that less than one in five physics teachers in Iowa have a physics degree; many are math and other science teachers recruited to teach a required course.

In an effort to address the shortage of qualified teachers, the Physics Department has been busy developing a series of online and blended courses to provide content training to teachers and expand their pedagogical content knowledge, continuing a long history of programs working to improve teachers' knowledge and practice. Online sections of the algebra-based General Physics courses are available each year for teachers who did not take introductory physics as part of their previous degree programs. Several years ago, Professor Larry Escalada and Associate Professor Jeff Morgan created Resources for Teaching Physics, which introduces teachers to active learning approaches, assessment techniques, and research into student learning. Morgan converted the class to a distance learning format two years ago, and each spring since the course has enrolled several teachers from a variety of locations around Iowa and beyond.

Now, Escalada and Morgan are working to develop two summer workshop courses, scheduled for alternating years, using PRISMS Plus and modeling instruction as the framework to build content and pedagogical knowledge. Teachers complete learning cycles, map those cycles to relevant NGS standards, and discuss classroom implementation. Initially envisioned for a blended format (one intensive week on-campus followed by three weeks of online coursework), COVID-19 has pushed the course entirely online for Summer 2020. Nonetheless, Escalada and Morgan are pushing ahead with modifications to the course schedule, and plan to offer mechanics training during the month of July. "This is a new environment and a new type of teaching and learning for all of us," said Morgan. "But online learning may be a big part of education in the coming years, and we want to be part of the community who figures out how to make this work, and deliver quality education regardless of format."

Additional electronics coursework on sensors and robotics, taught by Professor Tim Kidd, is also offered in a distance learning format. Through UNI Continuing Education, the Physics Department now offers enough credit that interested teachers may earn their State of Iowa 5-12 physics teaching endorsement, or the physics portion of the all-science teaching endorsement.

ALUMNI PROFILE

Wes Golden in Afghanistan.

Wes Golden

Wes Golden graduated from UNI in December of 1994, with a B.A. degree in physics. He also holds a master's degree in geosciences from Mississippi State University and a doctorate of education in teacher leadership from Northcentral University. Most recently, Golden has earned a master's in Strategic Studies from the U.S. Army War College.

Golden chose UNI because of several appealing characteristics. "I really enjoyed the size of the UNI campus and its student body," Golden says. "To pursue a discipline like physics at a smaller, student-focused university was fantastic; it was great to be in a department where the professors know you and the students know each other. In addition, I appreciated the education and training I received from the Army ROTC program at UNI. It has served me well and prepared me for a military career I could not (at the time) even comprehend was ahead of me!"

Like most alumni, Golden has particular recollections from his time in the Physics Department that stand out. "I was truly fortunate to learn physics from many dedicated professors," he declares. "I was also lucky to be a work-study student in the physics building setting up labs and building equipment for labs and experiments. That experience provided me practical opportunities to learn physics in a unique way. More specifically, learning about the art and craft of teaching physics from Dr. Roy Unruh was the highlight of my time at UNI!"

> "[My degree] has served me well in both of my careers in education and the military."

Golden's long and successful career as an educator is indeed powerful testament to Dr. Unruh's mentorship. He taught for over 20 years in the Clinton High School science department before assuming his current role of Director of Learning and Collaboration for the Clinton Community School District in 2017. "My degree in physics from UNI allowed me to confidently compete for physics teaching positions," he explains. "I was fortunate enough to teach physics for over 22 years before going into administration. But, more so, it provided me with critical, strategic, and deep thinking skills to solve complex problems. This has served me well in both of my careers in education and the military."

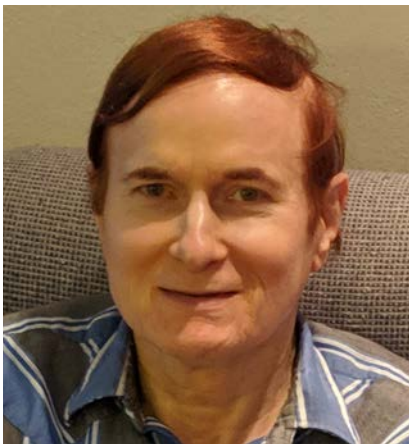
Golden began his service in the Iowa Army National Guard in 1997. As a Company Commander in 2003, he served in Baghdad, Iraq, and was deployed for more than 15 months in support of Operation Iraqi Freedom. Golden received the Bronze Star Medal, and his unit was awarded the Joint Meritorious Unit Citation. In 2010, Golden was promoted to Lieutenant Colonel and was selected as a Battalion Commander. In 2012, his battalion deployed to Afghanistan for one year in support of Operation Enduring Freedom. Golden's responsibilities included managing logistics for 18 separate NATO and non-NATO nations. He received a second Bronze Star Medal, and his battalion was awarded the Meritorious Unit Citation. In 2016, Golden was promoted to Colonel and became a Brigade Commander.

With his breadth of experience, Golden is a great source of sage advice for current physics majors. "Becoming a scientist affords you the opportunity to mess up and fail. Take the chance, even though you may fail. Embrace the process. Reflect and grow from each failure. How you respond to failure will far better tell you about your future than your successes."

Even a battle-scarred soldier and teacher has fun sometimes. "I love music, motorcycles, Hitchcock movies, and traveling. Even more enjoyable is just being with family and friends and enjoying the time we have together."

Golden and his wife Kristina live in Clinton, Iowa. They have two daughters, Prushia and Adelais. Prushia will be a freshman at UNI in the fall, with a major in Communications (Digital Media Production).

The entire Golden family is excited at the prospect of Prushia becoming a Panther. It certainly is a golden opportunity for her!



Larry Black

Larry Black was born in Beatrice, Nebraska and grew up in Waterloo, Iowa. He attended UNI from 1971 – 75, and departed with a B.A. in physics. He chose to pursue his degree at UNI for a few reasons. "I chose UNI due to its convenient location, its affordable cost, and I was impressed by the campus when I visited it in my senior year of high school in May 1969, for the Junior Academy of Science Symposium."

In the UNI Physics Department, Black found the professors to be friendly and also pleasant to work with because they treated students with respect. When asked, Black found it difficult to choose a favorite course. "I enjoyed all my physics and astronomy courses. I also enjoyed meteorology," he declares. "I have liked science since I became interested in astronomy in January 1960, while in 3rd grade." Black, however, had no difficulty identifying a favorite memory from his time at UNI. "My favorite memories are working as a Lab Technician for the Physics Department as a student. I built special projects for most of the professors, set up lab equipment for weekly labs, and maintained lab equipment. My most unusual experience was one day in the General Physics Lab, Room 101, I found what appeared to be three blasting caps in a lab drawer. When I was in grade school, we were trained to identify them and never touch them, if found. These looked just like the electrically-ignited type. I don't know what they could have been doing there, but did not touch them or take any risks, and called security. They came over and safely removed them. I never heard back if they were the real thing."

Black worked at Rockwell-Collins (in Cedar Rapids) in manufacturing for nearly 30 years before retiring in 2014. "I was a Senior Technician responsible for the analysis of manufactured circuit boards. I used various test apparatuses to analyze each board's function and determine if it was operating within specifications, or not. If it was not, I investigated why it was not operating properly, determined what needed to be done for it to operate within specifications, and then wrote a failure report to have it repaired. It was then re-tested until it passed." Black's physics training was useful for solving the problems that he encountered in his job. "I used my scientific training in applying the scientific method to problem analysis. I kept detailed records of what I observed, how I went about analyzing the observed symptoms, and then what solved the problem."

Black's advice to current students is wise. "Do the best you can in your studies and learn all you can. Keep a positive attitude. You do not know exactly what you will be doing in a career over the next 40 years, so you need to have a broad knowledge base to draw from, no matter what you do. You will likely change jobs several times during your career years. You will likely know more than you need to for any one particular job, but that is better than knowing too little." Amen to that.

In his spare time (of which he has more now), Black engages in astronomy and electronics. "I enjoy pursing optical astronomy and amateur (ham) radio. I designed and built my own 8" f/8.5 Newtonian telescope in high school, and a vacuum-tube radio transmitter while a student at Hawkeye Institute of Technology from 1969-71." He also enjoys reading, listening to classical music, and going to car shows to see 1950's and 60's cars. He owns a 1969 Chevelle SS 427.

Larry Black with his telescope.

RETROSPECTIVE

Reflections on my 30 years in the Physics Department

Becky Adams

My career at UNI began in April 1987, over 33 years ago. In September 1990 it was my good fortune to be selected to fill the position as Secretary II in the Physics Department. Roger Hanson was stepping back into the role of (Acting) Department Head because Jerry Intemann was named Interim Dean of the College of Natural Sciences (CNS). My prior experience at UNI had been varied, with a permanent half-time assignment in Curriculum & Instruction, temporary assignments in Engineering Services (now Facilities Management), Price Lab School Science Department (no longer in existence), English (now Languages and Literatures), and the Provost's Office.

Moving to the Physics Department gave me a permanent full-time position and was a promotion for me as well. I remember my first six months or so in the department very well. When I did not know how to accomplish a certain task, I would pick up the telephone and call a person in the area responsible – Registrar, Business Office, Physical Plant, ITS – and say, "Hi, I am Becky Adams and I am new in the Physics Department can you please tell me how to do…?" Seemed like I used that line for a long time as I transitioned through my first year of being a Department Secretary. Today, I would probably have to send an email message and hope for a timely response. The position has always been a solo support staff person which has worked great for me because I love to do a variety of work. Of course, Roger Hanson was very helpful and kind as I began this new position. My position has seen one upgrade in classification to Secretary III in August 1992 and I have served/transitioned with five Department Heads, Hanson, Behroozi, Macomber, Chancey, and Shand.

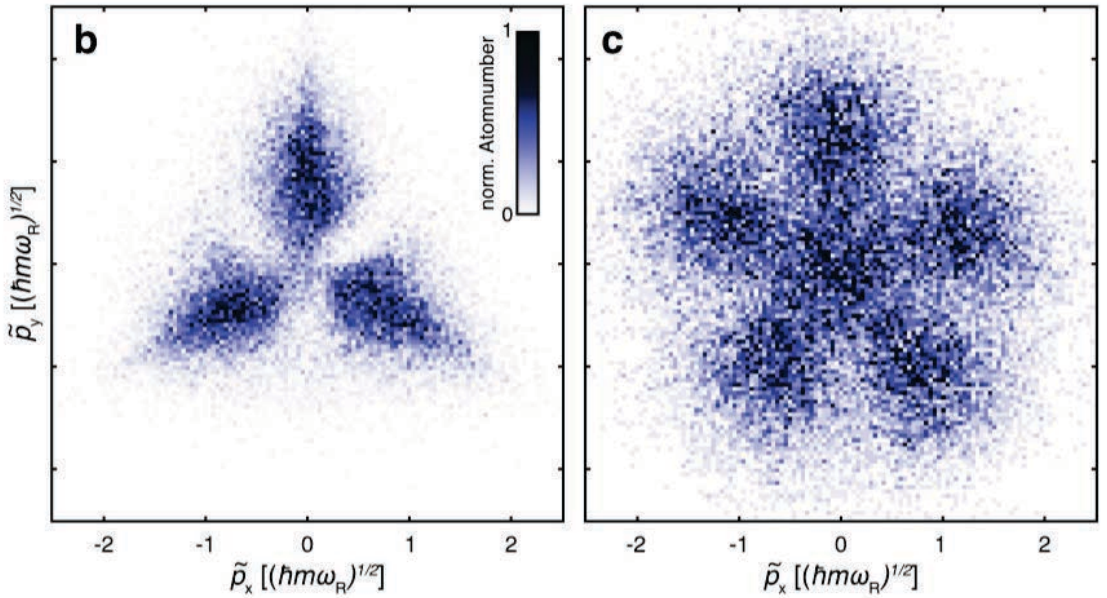
Traditions in the Physics Department have remained constant:

- The Annual Fall Picnic: Started with faculty, staff, and majors; now has developed into Physics Alumni Homecoming picnic for alumni, faculty, staff, and majors.
- The Holiday Colloquium: Always a fun and festive celebration at the end of the fall semester with faculty, students, and staff presenting plain demos, magic tricks and minor miracles. I can definitely say my favorite "minor miracle" over all the years was when faculty member Andrew Stollenwerk shrunk himself in a vapor cloud from liquid nitrogen and appeared about three feet tall on the demo table.
- The Physics Olympics Regional & State: (Now the Physics Competition): The International Olympics Committee contacted Larry Escalada in 2011 and told him he could no longer use the "Physics Olympics" name for the event because it violated the trademark name. This year the Regional event was dropped and the State Physics Competition was supposed to become an all-day competition until it was canceled due to the COVID-19 virus.
- Annual Physics Department Awards Banquet: Takes place during April each year to honor our graduating physics majors, scholarship and award recipients, Sigma Pi Sigma inductees, Physics Club Officers, and Summer Undergraduate Research Fellows.

One of the momentous events to occur during my career was the major renovation of the Physics Building. In December 2005 the Physics Office moved from its location on the second floor (an interior room with no windows and on the stairwell so the door could not be propped open because of fire safety, with room for just one visitor to sit down) to the Center for Energy and Environmental Education (CEEE) building. The renovation was completed in July 2007 and the office was moved back to the second floor but it is now much bigger with room for at least four visitors to sit down and it has three sets of double windows with great natural sunlight and probably is the nicest department office on campus! Needless to say I was thrilled because the only thing I had requested was one outside window. Overall the renovation of the building was amazing and is set up in a good, functional way. The lab classrooms make it easy for group work, we have one large tiered lecture hall, faculty research labs of experimentalists are located next to their offices. If you have not seen the renovation yet, you should really stop and visit and tour the department.

If you knew me when I arrived in the Physics Department in 1990 and you are familiar with all the Physics faculty in the department today, you know I am the longest serving person in Physics now. This means everyone who was here when I arrived is gone and we have a completely new generation of faculty and staff. I am so grateful for all 30 plus years I have served in the Physics Department and feel so blessed to be able to still say, "I love my job." I would be remiss if I did not mention one of the most important facets of my job as I see it and that is serving the students, especially the physics majors. I love to interact with and assist students when needed. I firmly believe it is one of my most important responsibilities. My transition from working full time to retirement has been made easier by phased retirement over the past two years. I am extremely grateful to Department Head Paul Shand for allowing me to do this.

In closing, I wish to acknowledge and thank each faculty and staff member I have worked with over the years and hope the future for the UNI Physics Department is bright and prosperous because the "Future is Physics."



Experimental Observation of Pauli Crystals

The distinct, periodic lattice of a crystal is due to the minimization of the electrostatic energy associated with the chemical bonds between the atoms, ions, or molecules of the material. Crystalline solids usually consist of a large number of particles (atoms, etc.); however, nanometer-sized crystals (nanocrystals) contain a relatively small number of particles. Further, relatively small collections of particles can also exhibit crystal-like geometric structures when the particles experience repulsive interactions and are confined in some way. An example is the vortex lattice. When magnetic field lines penetrate a Type II superconductor, they form vortices of superconducting current that arrange themselves spatially as a triangular lattice. Let's call these geometric structures formed due to actual forces between the particles "classical crystals."

It was theoretically predicted that spatially correlated structures could also be formed by small collections of particles that did not directly exert forces on each other as in classical crystals. In this case, the structures were due to the quantum nature of the individual particles. The Pauli Exclusion principle forbids identical members of a certain class of quantum particles from occupying the same quantum state in numbers greater than one. These particles are called fermions. Electrons, protons and neutrons are examples. A Pauli crystal is a correlated arrangement of fermions due only to the effect of the Pauli principle. Just such a crystal was recently experimentally confirmed by researchers at Heidelberg University in Germany. They used neutral lithium atoms (lithium-6) that were collected in an optical trap and confined by a harmonic-oscillator potential. It was necessary to cool the lithium atoms to very low temperatures to permit the wave functions of individual atoms to overlap. Coulomb (electrostatic) interactions between the charge-neutral atoms were negligible. The very low temperatures (and therefore energies) involved made the Pauli crystal a challenge to detect.

The measurements were made in momentum space using time-of-flight and fluorescence methods. The experimental observation of Pauli crystals depends on two critical factors: (i) the preparation of N non-interacting fermions in a well-defined quantum state, and (ii) the detection of correlations in the relative positions or momenta of these N particles. By recording a large number of different realizations of momentum distributions for the same initial state, the researchers were able to extract the desired density correlation function.

Momentum correlations among the particles (N = 3 and N = 6) are clearly seen in the images shown (taken from the article referenced below). The Pauli crystals were also made to "melt" by adding energy to the system. This work lays the foundation for future studies of correlations in systems of many fermions. For example, the researchers hope some of these experiments will shed light on the mechanism of Cooper pairing, which underlies superconductivity.

The article containing this work can be found at: https://arxiv.org/pdf/2005.03929.pdf

SUPPORT THE PHYSICS DEPARTMENT

Would you like to support the Department of Physics? If so, please fill out the form below and return it to:

UNI Foundation Financial Services
121 Commons, Cedar Falls, IA 50614-0239

_____
Name

_____
Address City, State, Zip

_____
E-mail Preferred Phone ☐ home ☐ cell ☐ business

Please check if new address, phone or e-mail.

I/we would like to support the following fund(s).

$_____ **Physics Student Research/Awards Quasi-Endowed Fund** provides support for scholarships and undergraduate research in physics (220193-20)

$_____ **Louis Begeman Quasi-Endowed Fund for Excellence in Physics** is a discretionary fund to support UNI Physics Programs (223636-20)

$_____ **Grossman-Perrine Endowed Scholarship Fund** supports an annual scholarship to a current physics major, with preference for a woman and minorities (211778-30)

Online: If you prefer, you may give via our website: https://www.uni.edu/physics. Use the "Donate to Physics" button on the left side. Please enter your donation amount in the boxes, or click "Take me directly to the giving page" to contribute to any other project (enter the project name or gift intention in the area marked "Please specify designation" in the "Other" category).

$_____directed to _____

My (or my spouse's) company, _____ (name), will match my gift.

(Please contact your HR office for details and matching gift form to be submitted with payment.)

Type of Payment:

Check: enclosed, payable to the UNI Foundation

☐ **Credit Card:** please charge my card
$ _____ beginning (mo/yr) ____/____
Please complete card information below.

Signature (required) _____ Date _____

Credit card information will not be kept on file 100509

Charge my: ☐ VISA ☐ MasterCard ☐ Discover ☐ American Express *(please check one)*
Card Number: _____
Expiration Date: _____

University of Northern Iowa

Department of Physics
215 Begeman Hall
Cedar Falls, Iowa 50614-0150

ALUMNI INFO REQUEST

LET'S HEAR FROM YOU!

Let us know what you have been up to. You can email us at physics@uni.edu or return this form to:

Department of Physics
University of Northern Iowa
215 Begeman Hall
Cedar Falls, IA 50614-0150

First Name _____ Last Name (maiden)_____
Address _____
City _____ State_____
Email:_____

Please share any news about you or your family to be included in the next Physics Newsletter.