CROSSSECTIONS

SUMMER 2021

UNI University of Northern Iowa

A MESSAGE FROM THE DEPARTMENT HEAD, **DR. PAUL SHAND**

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

Dear Friends,

Welcome to the 2021 issue of Cross Sections. Because classes and other university activities were conducted under COVID-19 prevention protocols during the entire 2020-21 academic year, several of our major events (e.g., Homecoming Picnic and the Begeman Lecture) were canceled. Thus, there are fewer departmental activities to report on this year. UNI offered mostly face-to-face classes during both the fall and spring semesters, with strict mask and social distancing requirements. There were no significant outbreaks at UNI because of strong adherence to COVID mitigation guidance. Improved room ventilation probably also played a role but it is incontrovertible that the students saved the day. They faithfully wore their masks and kept their distance (to the extent possible) indoors. After one gathering on College Hill at the beginning of the fall semester caused some embarrassment, they hunkered down and were a model of compliance throughout the academic year. Both semesters were especially difficult for the students because there were no breaks. (The fall semester ended before Thanksgiving and Spring Break was canceled.)

"...it is incontrovertible that the students saved the day."

Like many other colleges and universities, enrollment at UNI was down several percentage points for the just completed academic year. We are all hoping that the prospect of normal classes next fall will result in the return of students who decided to put their education on hold because of various pandemic-related issues.

I have mentioned the effort to reform the UNI General Education program (now called the Liberal Arts Core) in previous issues of this newsletter. That multi-year endeavor is now complete. Departments that wish to offer courses (existing or new) for inclusion in the new program have submitted applications. The applications will be judged based on metrics related to how well the new student learning outcomes have been addressed. As I have commented before, it is somewhat disappointing that the new Scientific Reasoning category can be satisfied with one science lecture course and a lab. The course and lab can either be physical science-related or life science-related. Currently, one life science course and one physical science course must be taken. The justification for the reduction (apart from a desire to reduce the length of the program) is the new emphasis on interdisciplinary collaborations. There is a new General Education certificate that requires courses from several learning areas, which serves as a kind of capstone for the program. The new program certainly presents an opportunity for Physics to conceive new courses that can attract a broad audience.

You may have heard that our current provost, Jim Wohlpart, announced at the beginning of the spring semester that he is leaving UNI for the presidency of Central Washington University. With the aid of a search firm, UNI undertook a search on a very compressed timeline, with the aim of having Wohlpart's replacement on campus by July 1.

(Continued on next page)

I was a member of the search committee, and after many meetings and a demanding interview process, UNI's next provost, Dr. José Herrera, was announced on May 26. Dr. Herrera is a biologist and is currently the Provost and Executive Vice President of Academic Affairs at Mercy College in New York. Comprehensive universities like UNI have played a significant role in the trajectory of Herrera's life. We hope that as UNI's chief academic officer, he will chart an upward trajectory for the institution at a critical time in its history.

It is worthwhile to mention that UNI recently completed a successful re-accreditation process. Re-accreditation typically occurs on a 10-year cycle and involves a highly detailed examination of a university's operations. Academic assessment in the General Education program and also in the broader curriculum was an area of some weakness in the last accreditation process. Since then, UNI has made great strides and I am happy to report that the accreditors were very pleased with UNI's performance in assessment and all other areas of evaluation. This is excellent news and an appropriate reward for the hard work of the Steering Committee and its many subcommittees over the past three years.

Moving to departmental news, we have seen an uptick in external research funding over the past two years. Last year, I reported that Tim Kidd and Andy Stollenwerk were awarded a $328,000 grant from the Department of Energy to study quantum confinement effects at metal-semiconductor interfaces. Since that report, Pavel Lukashev has been awarded a $236,000 grant from the National Science Foundation to study half-metallic and other spin-polarized states in Heusler alloys. Lukashev will perform computational studies, and a collaborator at South Dakota State University, Dr. Parashu Kharel, will grow the materials and perform some experimental measurements. I will also assist with electrical transport and magnetic measurements. UNI Physics faculty member Ali Tabei was also successful in obtaining $5,000 from the Iowa Science Foundation to model homologous DNA repair. Tabei also received a $10,000 grant from the Iowa Space Grant consortium to develop a Data Visualization course, which is a component of our new data science curriculum.

You will recall that long-serving Physics secretary Becky Adams retired last year. I am happy to report that Ashley Taylor is our new secretary. Ashley started in November and splits her time between Physics and Biology. You can read more about Ashley in the Department Happenings section.

Our students continued with their research, service and outreach activities despite the pandemic. I'll mention here that the only two nominees for the national Goldwater Scholarship competition from UNI this year were physics majors. I doubt this has ever happened before and is at least partially attributable to the fact that physics majors continued with research activities through the pandemic. We report on student activities in more detail in the Focus on Students section.

Let me close by thanking you for your unwavering support for our students and programs. Your generosity makes it possible to continue to support our majors with research fellowships and scholarships even while state support for the institution has steadily eroded. We are planning to host our annual Homecoming Picnic in person at noon on October 2nd at Seerley Park. It will be wonderful to meet and catch up. In the meantime, please take care of yourselves.

Sincerely,

Paul Shand
Professor and Head

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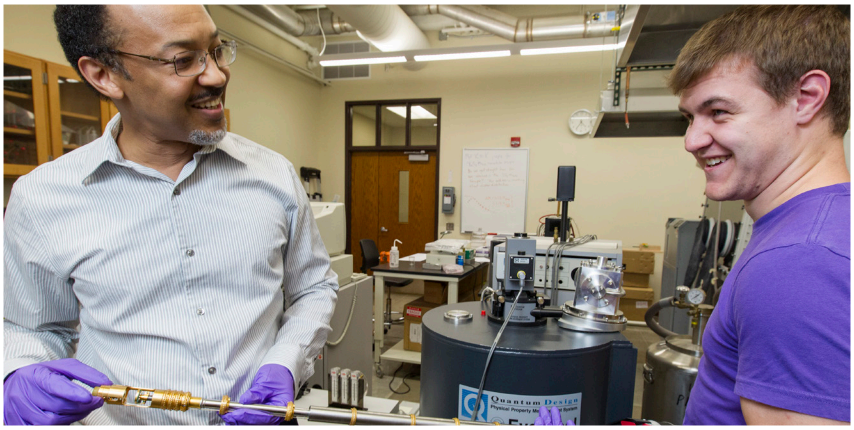
FACULTY PROFILE



Dr. Shand in the lab with student Corey Cooling

Dr. Paul Shand

Paul Shand began his professional journey in physics as an undergraduate at the University of the West Indies in Kingston, Jamaica. After completing his bachelor's degree, he pursued graduate studies in physics at Purdue University in West Lafayette, Indiana. At Purdue, Shand completed M.S. and Ph.D. degrees in physics.

Shand first became interested in physics when he first learned about what many would consider a rather boring concept. "It was density," Shand says wryly. "It seems a bit weird to have been excited by density."

It didn't take very long for Shand to divulge that there was more to the story. "My older brother came home one day and started talking about density, which he had presumably just learned about in school. He knew I wouldn't have known what it was, which is probably why he brought it up." Shand decided to find out what density was (asking his brother was out of the question) and a physicist was born.

During his time as an undergraduate, Shand worked as a tutor and developed a love for teaching. "It was very rewarding to explain things to other students so that they understood," Shand enthused. "I wanted to be a professor at a university where good teaching was primary but research was also important. UNI is an excellent embodiment of such a place." In addition to the professionally appealing mix of teaching and research, Shand found the UNI Department of Physics to be an exceptionally welcoming place. "When I first arrived at UNI and was climbing the stairs from the north entrance, Kent Macomber hollered my name from the second-floor landing." "Paul Shand!," he boomed. "You're here." "Kent had a big grin on his face and made me feel right at home. The other physics faculty and the staff were also wonderfully welcoming and friendly. After nearly 29 years, the physics department continues to be very collegial and an amazing place to work."

In the recent past, Shand has taught General Physics I, Modern Physics and Modern Physics Lab most frequently. Shand was the first faculty member at UNI to develop and teach General Physics I in an online format. One online section of General Physics I has been offered each year for several years. Experience with the online delivery of the course turned out to be very useful when the COVID-19 pandemic struck and UNI had to suddenly switch to online-only instruction. "We already knew what tools were needed and had worked with simulations as lab replacements. Thus, the switch was not quite as jarring or disruptive for us."

Shand conducts experimental research in the broad area of magnetic materials. Much of his work over the years has focused on phase transitions in a variety of disordered or diluted magnetic materials. In these materials, atoms of a magnetic element such as manganese are either partially substituted for non-magnetic atoms at crystal-lattice sites or inserted (intercalated) between atomic layers of an otherwise non-magnetic material. In many cases, the introduction of disorder into the arrangement of magnetic atoms leads to exotic magnetic states such as spin glasses. Spin glasses exhibit a variety of fascinating properties, including non-equilibrium behavior. Disorder may also cause changes in the magnetic behavior close to a transition. In many cases, such changes are due to the formation of clusters of magnetically ordered atoms. Shand is currently collaborating with Physics faculty member Pavel Lukashev to study various materials in which the electric current is either wholly or partially polarized, i.e., the electrons participating in current flow have their spins (magnetic polarities) aligned. Such materials may one day be the basis of a new spin-based electronics technology that simultaneously incorporates logic, storage and communication for information processing.

The thrill of discovery is the driving force behind many research careers, including Shand's. For Shand, there is an additional thrill. "Working with students is an absolute joy for me," he says. "It's amazing to watch them learn and grow as scientists over a short period." When not engaged in professional activities, Shand loves to take long walks early in the morning. "Before all the hustle and bustle starts, it's quiet and peaceful," he says. "It's wonderful to just absorb the sights and sounds of nature."

DEPARTMENT HAPPENINGS

Meet our new secretary: Ashley Taylor

Ashley Taylor

Ashley Taylor joined the Physics family last November as our new secretary. Before coming to UNI, Ashley worked at Principal Financial Group as a Client Implementation Manager and prior to that, she was a math teacher at Waterloo West High School.

Ashley works half-time in Physics and half-time in Biology. Ashley, her husband Kyle, and their three kids live in Cedar Falls.

Class of 1943 Awardee: Jeff Morgan

Jeff Morgan

Physics faculty member Jeff Morgan is this year's winner of UNI's Class of 1943 Excellence in Teaching Award. The Class of 1943 Award is UNI's foremost teaching award. The recipient is chosen by a highly competitive selection process. We are all very proud of Jeff!

Zoom meeting during Beyond Frozen camp. Everyone is smiling because fractals are fun!

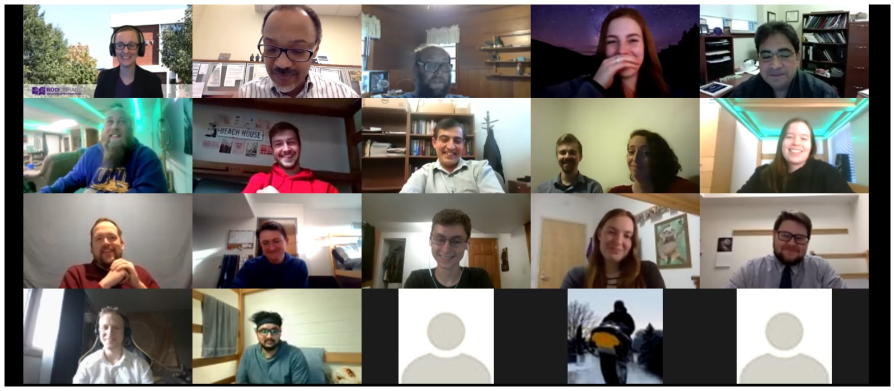
Beyond Frozen Camp

Physics faculty member Ali Tabei, UNI STEM Coordinator Marcy Seavey, and physics major Sophie Roberts teamed up to offer the Beyond Frozen for middle-school kids last summer.

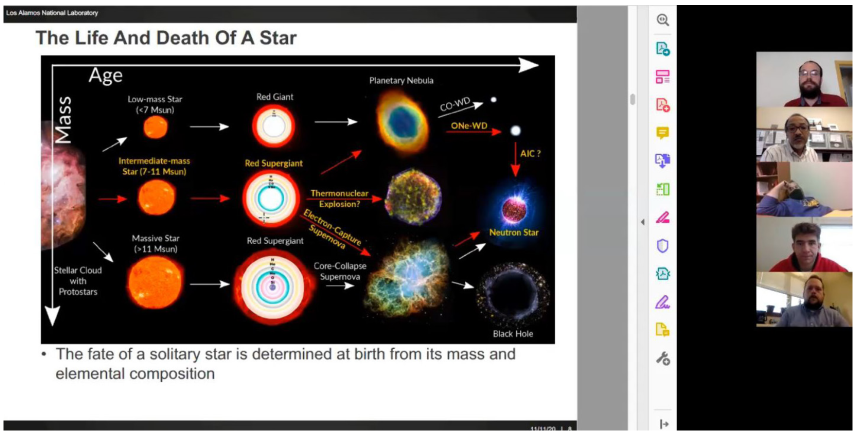
During the camp, participants learned about fractals. Meetings were held via Zoom and kits were sent to the kids so that they could build fractal-oriented structures themselves. It was great to be able to offer this camp in the middle of the pandemic!

Virtual Physics Awards Ceremony

For the second year running, our annual Physics Department "Banquet" was a virtual event, with attendees brought together by Zoom. The guest speaker was Anne Marie Gruber, Asst. Professor of Library Services, who talked about information and science in the public sphere. Congrats to award winners and graduates!



Attendees laugh at something very funny that the host said (that the host doesn't remember).



Dr. Wes Even (Los Alamos National Lab) talked about neutron star mergers and their role in creating heavy elements throughout the universe.

Physics Colloquia

We took advantage of only being able to host meetings via Zoom to invite more external speakers for our Physics Colloquium series. We had speakers from far-flung places such as Andover, Massachusetts, Los Alamos National Lab in New Mexico and the University of Waterloo in Canada. It was a treat to learn about the interesting research going on at all these locations.

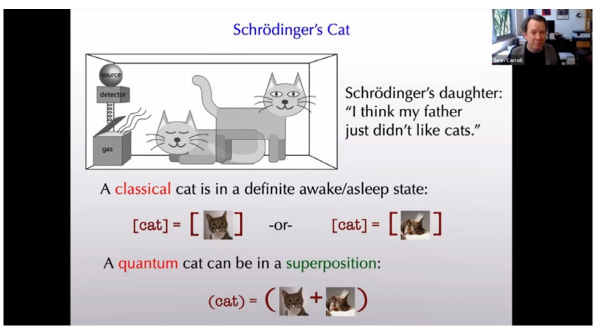


Illustration from plenary speaker Dr. Sean Carroll (Caltech), who spoke about "The many worlds of quantum mechanics."

UNI President Mark Nook delivers a rousing welcome to open the proceedings at the SPS Zone 11 meeting.

SPS Zone 11 Meeting

The 2021 Society of Physics Students Zone 11 Meeting was hosted by UNI on February 19 – 20, 2021. The meeting was virtual, with students from all over Zone 11 (Iowa, Nebraska, Minnesota, North & South Dakota) in attendance. The meeting was organized by student Taylor Walters, ably assisted by UNI STEM Coordinator Marcy Seavey, and Physics Club Co-Presidents Sophie Roberts and Aaron Janaszak. A great time was had by all!

STUDENT FOCUS

STUDENT PROFILE

Taylor Walters

Taylor Walters hails from Marion, Iowa and attended Marion High School. She recently graduated from UNI with a B.S. in physics and a B.A. in physics teaching. She originally chose UNI because she wanted to become a chemistry teacher and initially majored in Chemistry Education. "I decided over the course of my freshman year that chemistry was not the only science subject I wanted to be involved in, so I added a second major in Physics Education, but the timeline also changed over my time at UNI," she says. "It would be apt to say that I missed 'doing physics,' and I sought the challenge. I also chose UNI because I was inspired by many of my teachers in high school who were notably UNI graduates."

When asked what she likes most about UNI, Taylor responds, "UNI held several opportunities for me to grow both personally and professionally. The small college feel accompanied by many opportunities created a great college experience. I enjoyed building impactful relationships with several professors and staff, who helped me achieve and experience many things."

Taylor's interest in science goes all the way back to kindergarten. "I always think back to my kindergarten classroom where my teacher had set up a dinosaur bone dig in the schoolyard," she reminisces. "We used our brushes and mini-shovels to uncover a T-Rex right in Marion, Iowa!" Taylor is just warming up. "Our 'Day at the Caves' included spelunking through the classroom window and building (fake) fires as a way to see in our blacked-out learning space," she enthuses.

"I also chose UNI because I was inspired by many of my teachers in high school who were notably UNI graduates."

As her education advanced, Taylor realized that she had an affinity for math and science, and she knew that she wanted her future career to involve the sciences. "I initially chose physics teaching (after chemistry teaching) as my major for two reasons; my high school science teacher (Madi Ramaekers, who is a UNI Physics alum) was a wonderful inspiration to pursue the sciences, and I wanted to pursue a science teaching career as I love to help people and students learn and explore the topic."

As Taylor continued her coursework in college, however, her career aspirations morphed into a focus on wanting to apply her knowledge in the field of technology and/or science. "At that moment, I decided to pursue a B.S. in Physics alongside Physics Education with the goal of continuing my education and applying my scientific knowledge in a more technical field," she explains.

As a B.S. major, Taylor dove into research with Physics faculty member Tim Kidd. Her project was titled "Creating Methodology for Thin-Layer Transition-Metal Dichalcogenide Exfoliation via Gold Substrate." Taylor has presented her work at various conferences, including American Physical Society/Society of Physics Students PhysCon 2019, the largest undergraduate physics student gathering in the world. "I have a motto to always try new and hard things, as you never know what may come of that opportunity," she declares. "Research proved to be a wonderful learning and development experience. The greatest value I received from doing research was seeing the success in doing something unique and challenging, and how that applied to my learning, my experiences, and my current ambitions."

Taylor was also heavily involved in UNI Physics Club activities. She was the Co-President for the club during the '18-'19 and '19-'20 academic years. "This club became my passion as I helped revive the chapter at the end of April 2018 with the help of Joseph Tibbs," she states. "The club went from virtually no activity to having very successful events such as a tour of Fermilab, a trip to Providence, Rhode Island for PhysCon 2019, and many gatherings, study nights, and picnics that built great friendships and department camaraderie."

Taylor currently serves as the Associate Zone 11 Councilor for SPS. (Zone 11 includes Iowa and surrounding states.) She organized the SPS Zone 11 meeting held at UNI in February. Chi Alpha, a campus ministry, was also a central part of her extracurricular activities at UNI. She attended worship services, was a small group leader, and was a singer in the worship team.

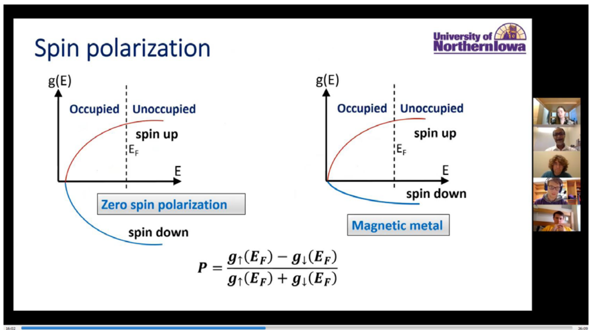
Taylor recently took a position with BAE Systems as a Systems Engineer in the Navigation and Sensor Systems department, where she helps maintain and fulfill contract requirements for military GPS user interfaces. Taylor and her husband Zach live in Cedar Rapids.

STUDENT FOCUS

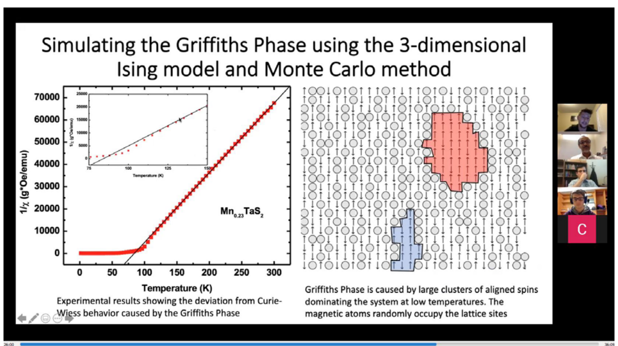
Student Research

Ten students received summer undergraduate research fellowships for computational research projects undertaken during the pandemic summer of 2020. Fortunately, the UNI Physics Department houses two computational physicists; however, experimentalists were also flexible enough to shift students to computational projects.

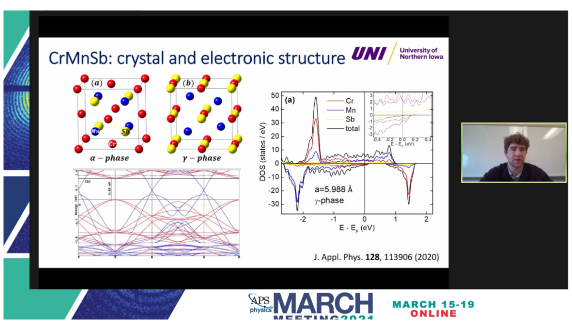
The students presented their results at the annual Summer Undergraduate Research Symposium at the end of the summer period and at departmental colloquia in the fall.



Devon VanBrogen explains his research on half-metals.



Paul White discusses exploring the Griffiths phase using the 3D Ising Model.



Adam Ramker presents his results on CrMnSb at the 2021 APS March Meeting.

Goldwater Scholarship Competition

The Barry M. Goldwater Scholarship is arguably the most prestigious and competitive national undergraduate scholarship. The UNI Physics Department has been the home of two Goldwater winners and two students who received "Honorable Mention" awards. This year, UNI nominated only two students for the competition and both are physics majors. Juniors Aaron Kirchman and Sophie Roberts were nominated and though they did not win awards, they made us tremendously proud!

Sophie Roberts

Aaron Kirchman

STUDENT RESEARCH

Lukas Stuelke

Aaron Janaszak

How can scientists determine the properties of materials that are only a few atoms thick? Are there any unique properties that are hidden due to the tiny length scale of certain materials? During the summer of 2020, B.S. Physics majors Aaron Janaszak and Lukas Stuelke worked together under the supervision of Dr. Paul Shand to create a computational model to probe the magnetic properties of a certain material that are of both fundamental and practical interest.

The material that Janaszak and Stuelke studied was tantalum disulfide intercalated with manganese (Mn_xTaS_2). Intercalation refers to the insertion of foreign atoms (Mn in this case) between the atomic layers of a host crystal. The quantity x is the atomic fraction of intercalated Mn atoms. In ferromagnetic materials, there is a sharp transition from paramagnetism to ferromagnetism that takes place at a specific, material-dependent temperature called the Curie temperature. Paramagnetism occurs at high temperatures, which have a randomizing effect on the magnetic alignment of the individual magnetic atoms. Because of the random magnetic alignment directions of the atoms, the overall magnetic alignment (i.e., magnetization) is zero in the absence of a magnetic field. In the ferromagnetic state, the strength of interaction between magnetic atoms overcomes the randomizing effect of the thermal energy at lower temperatures, which causes magnetic alignment of individual magnetic atoms over large regions of the material; there is an overall magnetization in these regions.

"Paramagnetism occurs at high temperatures, which have a randomizing effect on the magnetic alignment of the individual magnetic atoms."

In materials in which the positions of magnetic atoms are disordered, there will be distinct, separate clusters of neighboring magnetic atoms. There will be a distribution of cluster sizes; in particular, there will be a few that are very large in size. When the Curie temperature is approached from above (in the paramagnetic state), these large clusters may become aligned and affect the overall magnetic behavior of the system, even though the entire material is yet to transition to ferromagnetism. This cluster-dominated state is called the Griffiths phase. Behavior characteristic of the Griffiths phase was observed experimentally in Mn_xTaS_2 with certain concentrations (x) of Mn.

The focus of Janaszak and Stuelke's project was to use a simple cluster-based model to try to reproduce the Griffiths phase behavior observed in Mn_xTaS_2. The Griffiths phase is essentially a sequential magnetic ordering of clusters of various sizes. The code was written in MATLAB. In the model, clusters did not interact with each other but the magnetic atoms in a cluster interacted via a field proportional to the cluster's overall magnetization. The clusters were given a size distribution and each cluster was taken to be fully magnetically aligned below its Curie temperature.

Janaszak and Stuelke were able to qualitatively reproduce Griffiths phase-like behavior in the magnetization as a function of temperature and magnetic field. In smaller magnetic fields, the clusters dominated the behavior, which led to more significant Griffiths-phase effects. In larger magnetic fields, the aligning effect of the field dominated the behavior, so standard paramagnetism was exhibited. The team also studied the effects of the number of clusters and the cluster size distribution on the Griffiths phase-like behavior.

ALUMNI PROFILE

Troy Errthum

Troy Errthum grew up in rural Dubuque County not far from the Field of Dreams. The family lived on a small farm in a wooded valley. "My father was a factory worker and my mother a bus driver," he says. "I spent a lot of time hiking, playing with Legos, and engineering dams along the stream that flowed through our property."

Troy attended UNI from the fall of 1991 to the fall of 1995. He chose UNI mostly because of a full tuition scholarship he had through the Mathematics Department. During his freshman year, Troy took the Conceptual Physics General Education course taught by Dr. Roger Hanson. "I loved it!" he raves. "So, I declared Physics as my second major and finished with a BA."

Errthum also loved the UNI campus. "It was small and compact, easy to get anywhere," he declares. "And, great to rollerblade on! I also loved Cedar Falls. It's a great little Iowan city."

Errthum loved all the lab classes he took as a physics major. Everything from studying momentum on the air tracks in Physics I to making holograms in Optics. "I have always enjoyed hands-on science," he enthuses.

When asked if he has a favorite Physics Department-related memory from his time as a student, Errthum replies, "Oh my gosh, where to start on that one! I really liked the camaraderie among the students and staff. This led to so many fun times just hanging out in the Physics Student Room while studying."

After graduating, Errthum got a job working on computer shipping systems with Pitney Bowes. His next job was fixing Y2K bugs. Though Errthum did not have a computer science degree, EDS (his employer) was desperate for programmers, so he taught himself to program. Errthum then went to work for Nationwide Insurance. All of these jobs were in Des Moines, Iowa. By 2016, he was a Software Specialist and had experience in everything from Mainframes to UNIX and COBOL to .NET.

In 2016, Errthum left the (paid) work force and became a house spouse. His wife Marty, also a UNI grad, had studied medicine and became a physician. The family moved to Knoxville, Iowa, that year. Volunteering has become Errthum's new life. He has read to grade schoolers, sometimes while in character. He also occasionally helps out with science labs in the middle school when they need an extra set of eyes or a physics mindset.

Errthum is also the lead set builder for the high school's drama department. He is currently the vice president of the school's music boosters and a die-hard "band dad." In addition, volunteering in community theatre has also become a passion of his. "I do a lot of stage light design and programming for several groups in the county," Errthum says. "I have also acted in many productions since moving here, something I wish I would have done sooner."

Working towards a physics degree helped build Errthum's logical thinking and sharpen his cognitive abilities. These proved very useful in his IT career. Errthum also learned a lot of people skills while taking classes, doing research, and working for the department. "I did get to use some knowledge directly when in the late 90's I contracted with a Swedish company to build a Java-based pinball game to be used in Europe's largest online casino at the time," he remembers. "My knowledge of gravity, friction, and collisions proved very useful there."

What advice does Errthum have for current physics majors who will soon be seeking employment? "Networking for me was everything," he emphasizes. "If there are recruiters on campus, or a job fair somewhere, go! Even if the jobs might not be directly physics-related, start talking to people. When most employers hear that you have a degree in physics, they know that you are smart and can do whatever you put your mind to. Make sure to lean on resources at the college and in the department."

For fun, Errthum still does a fair amount of computer programming. He just finished coding a virtual ant farm during the COVID lock down. "Yo-yoing is a passion of mine and I have competed at the Iowa State Fair," he says, proudly. "A large collection of yo-yos adorns my wall." You can also find Errthum looking into a telescope whenever there's something cool to see skyward. He always has some weird project in the works. "My favorite thus far is my full scale Jar Jar Binks in Carbonite."

Errthum and Marty have three children. Travis and Trevor are twins, both in college. Tanner, the youngest, will be a junior in high school in the fall. The family still lives in Knoxville, "Sprint Car Capital of the World."

ALUMNI NEWS

Wesley Even

Wesley Even received a B.S. degree in physics from UNI in 2003. During his undergraduate years, Wes was a model of quiet excellence. He was never the most loquacious student in the class, but he had a sunny smile when something animated him.

The smile was especially broad after he had aced an exam. After leaving UNI, Wes went to Louisiana State University (LSU), where he received both a master's degree and a Ph.D. in physics. His research was in the computational fluid dynamics of astrophysical systems. He did postdoctoral work at Los Alamos National Laboratory for a couple of years and was subsequently hired at Los Alamos as a scientist.

Wes has risen through the ranks and is now Deputy Group Leader of the Computational Physics and Methods Group, CCS-2, at Los Alamos. CCS-2 includes multidisciplinary teams composed of engineers, physicists, applied mathematicians, and computer scientists, collaborating in application areas such as neutron and radiation transport, shock hydrodynamics, multiphase fluid dynamics, turbulent mixing, ocean dynamics for climate modeling, astrophysics, and plasma physics.

Wes was keynote speaker at the UNI Summer Undergraduate Research Symposium in July of last year. Wes also gave a physics colloquium in November, titled "Searching for the Origin of Gold in the Universe."

In that talk, Wes discussed new observational data resulting from the merger of two neutron stars and how such events seed heavy elements throughout the universe. Wes also provided much-appreciated information on undergraduate research opportunities at Los Alamos!

SCIENCE EDUCATION

Whither Online Physics?

Last spring when all universities were under lockdown, every course, from Anatomy to Zoroastrianism, shifted to an online or virtual delivery system. Before the pandemic, we would never have thought it possible that the shift could be made so quickly (a little more than a week at UNI), or made at all in some cases. However, as they say, necessity is the mother of invention.

All university courses moved online, with varying degrees of success as measured by the faculty themselves and the students. Now that we are on the cusp of going back to normal instruction, what should we do with this experience with online teaching? It probably wouldn't be very difficult to continue to offer a lecture-only course on Zoroastrianism online. Learning management systems such as Blackboard are quite good and getting better, and meeting platforms such as Zoom offer reasonably good mechanisms for students to interact among themselves and with the professor via Chat and Breakout Rooms. But for Anatomy (and Physics), there are labs. How do we conduct experiments online and provide a decent facsimile of the in-person experience?

In physics, we used a combination of simulations and student kits. Simulations such as the University of Colorado Boulder's PhET series are extremely well designed, easy to use via a browser, and built on the foundation of science education research. We used PhET and other simulations almost exclusively in General Physics I and General Physics II — the algebra-based introductory courses that enroll the vast majority of students who take physics at UNI. The use of simulations as lab substitutes is probably fine for courses like General Physics.

After all, these courses are taken by students who major in some other science, and are likely receiving authentic lab experiences within their major. But what about lab courses in the physics major? During lockdown, we taught Physics II for Science & Engineering, the second part of the calculus-based first-year sequence, using both simulations and demonstrations.

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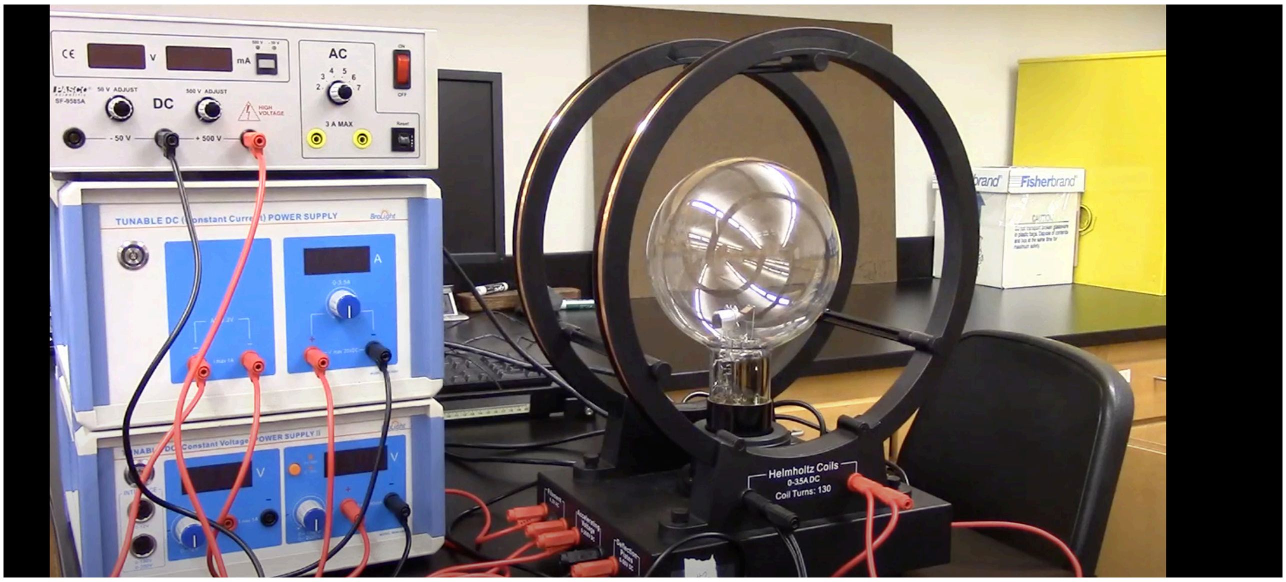
SCIENCE EDUCATION



Video recording of electron beam in a magnetic field

This strategy worked well in an emergency situation. But would we want physics majors to go through lab courses without actually physically handling equipment and contending with how to set up devices correctly to collect the necessary data?

One solution allowing hands-on experience is to provide students with kits that they can use to conduct experiments.

Such kits can be purchased from commercial sources. Of course, these kits will not be able to duplicate the full in-person lab experience, but at least the student has an opportunity to physically conduct simple experiments with real equipment. The array of sensors available within most smartphones provides another tool that can be used for remote learning about motion, light, and sound.

As physics graduates who have gone through the full-bore lab experience ourselves, we feel deeply that physical experimentation is important, especially to prepare students for careers in systems engineering and the like, or in research. The problem of providing authentic lab experiences becomes even more difficult at higher levels in the physics curriculum. How do you teach Modern Physics Lab or other advanced lab courses online?

Last spring, we used video to show the students the equipment and how to set it up. The instructor then performed each experiment and provided students with the data for analysis. This was sufficient in an emergency, and the quality of the lab reports did not change for the virtual experiments. However, the experiments in Modern Physics Lab involve relatively complex apparatus, and students definitely learn skills (e.g., following written instructions and getting stuff to work) in navigating these experiments.

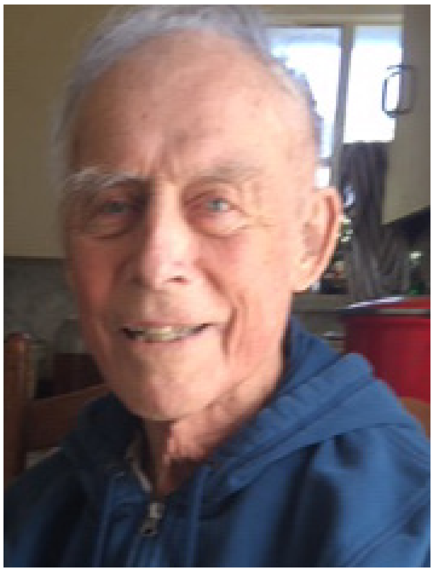
In the future, virtual reality and remote access to computer-controlled instrumentation will provide better verisimilitude for online students. However, in the more immediate timeframe, we need to seek the best solutions with currently accessible tools.

In a world in which online physics labs were only needed in emergencies, we would not have to worry too much about these issues. However, online education is an area of growth in an otherwise fairly dismal enrollment picture. Every senior administrator is interested in increasing online offerings, whatever the subject area.

The UNI Physics Department must confront this reality. We are fortunate, in that we have deep pedagogical expertise in our department. Our job is to find ways to provide authentic lab experiences, or more precisely, lab-like experiences for students at a distance.

We will continue to offer the rich and excellent in-person lab instruction that the readers of this newsletter experienced and enjoyed. However, we must also seek new and innovative methods to extend our reach.

IN MEMORIAM



Bob Ward

Robert Theodore Ward was born on June 10, 1931 in Newton, Massachusetts. Bob spent his childhood in Newton, Massachusetts taking summer holidays with his family in Provincetown, hiking and sailing. His mother had been a nurse, his father a doctor. Both parents had spent time in Turkey as medical Congregational Church missionaries.

Bob went to Amherst College, graduating in 1953, then on to Harvard for his doctorate, granted in 1959. His first teaching job was at Harvey Mudd College in Claremont, California. Bob and Marjorie Hanzlik Hertel married, and daughter Emily was born. During his second teaching job, at Williams College, in Massachusetts, they were divorced.

In 1965, Bob took a position with the Ford Foundation, helping edit a Science textbook at the University of the Philippines. He worked there four years, traveling widely in the islands. In 1967, Bob and Nina de Creeft Miller were married. They went back to the Philippines with her three sons, Chris (10), Alex (8), and Adrian (5), for the last two years with Ford Foundation. In 1969, Nina's mother, Alice de Creeft, made a visit to Quezon City. Granny brought the boys home, while Bob and Nina traveled through parts of India, Pakistan, Afghanistan, Iran, Turkey, Lebanon, and Spain. They had traveled in Cambodia and Thailand while living in the Philippines. Bob loved to travel.

Bob and family came back to the United States to teach at the University of Chicago in 1969, in the Department of Science Education. Emily (10) joined the family just before son Nathaniel was born in 1971.

Bob next taught in Physics and Science Education at the University of Northern Iowa in Cedar Falls for twenty-six years. Bob and Nina made two trips to Taiwan to work with Taiwanese science teachers on UNI degrees. They also went twice to Mainland China for pleasure. In 2001, Bob retired and moved with Nina to her mother's home in Santa Barbara.

A dedicated science teacher, Bob worked with a Chicago group on elementary science textbooks after retirement. He volunteered at Harding elementary school.

He enjoyed gardening, took long walks with various dogs, and was an avid rower. He rowed his single ocean shell out of the harbor in Santa Barbara as long as health permitted.

He loved to read, and he loved classical music. Bob and Nina attended Trinity Episcopal Church, where Bob was active in the Science Club. Bob picked up injured animals for Santa Barbara Wildlife Care.

As a person, Bob was not a great talker, but he made his views clear. He had dignity and strength of character, and he was forgiving and generous. He had a wicked sense of humor. Son Nat and his wife Michelle came here to help when Bob's health began to decline. They were a joy to him. Bob's daughter Emily had donated a kidney to Bob, which lasted for ten years, but by this time Bob had been on dialysis and had also suffered pain from a case of shingles for seven years, though he rarely complained.

All the family has been very supportive. Hospice nurse Marianne has been a wonderful help, along with the staff at Artificial Kidney of Santa Barbara and Cottage Hospital.

"He had dignity and strength of character, and he was forgiving and generous."

Bob died on January 11, 2021 at home in Hospice with family around him. He had suffered a variety of health difficulties over the past few years, and most recently, a broken hip.

Bob is survived by his wife of 52 years, Nina, his son Nathaniel (Michelle), his daughter Emily (Barb), and his step-children, Katy Hertel, Christopher Miller, Alexander (Linda) Miller and Adrian (Genevieve) Miller, grandchildren Jack and Davy, Sierra and Dorian. Bob is also survived by his sister Ann Curby, his nephew Mark Curby, his niece Judy Curby (Gayle), niece Cathy (Birch) Curby, her son Coryn, and many cousins.

IN MEMORIAM

Ralph Engardt

Ralph Duane Engardt was born on September 18, 1931, to Rudy and Myrtle Engardt. They lived in Omaha, Nebraska, and had three children: Ralph, JoAnne (Eledge) (deceased), and Jerry (who still lives in Omaha.) Ralph graduated from South High School in Omaha in 1949, and was awarded an ROTC scholarship. He continued his education at Iowa State University.

Before Ralph graduated with his BS degree and his doctorate in physics from Iowa State University in 1964, three significant events shaped the rest of his life: He met and married the love of his life: Edith Paskach, on June 15, 1953. She is the youngest of nine children, and they were partners and the best of friends for the rest of Ralph's life. (Married 67 years, 7 months, and 13 days!)

Ralph was commissioned into the Navy on 12 June 1953, and served for 2 years, 11 months, and 19 days. Lieutenant Junior Grade (02) Ralph D. Engardt received 2 medals, and was honorably discharged on May 31, 1956. While in the Navy, Ralph was separated from his wife in service of his country while event #3 occurred: Edith gave birth to their first of 5 children: a girl! Debbie Lynne (King) was born on November 12, 1954. Before Ralph graduated with his doctorate in 1964, 4 more children were added to the family (and into the "cozy" 2-bedroom apartment in Student Housing): Cindi, Sue, Bob, & Gary.

Ralph accepted a position as an assistant professor of physics at the University of Northern Iowa, where he taught for 30 years, until his retirement in 1995. The family moved to Cedar Falls – which is still the 'family home' to this day. They became regulars at the United Methodist Church of Cedar Falls, slipping into the back row of the balcony with the first or second song, and slipping out with the last hymn.

Ralph also put his physics to work in a practical way for a period of time: From 1979 to 1983, Ralph and his long-time friend and colleague Roy Unruh, built and sold Terra Domes (earth-sheltered, modern looking, energy-efficient homes.) This also provided gainful employment to Ralph's sons Bob and Gary for a period of time.

After Ralph's retirement in 1995, he helped care for his parents in Omaha. By then, 4 of his children had headed west: Sue to Seattle, WA; Gary to San Diego, CA; Bob to Solana Beach, CA; and Cindi with her husband to Dana Point, CA. Ralph and Edie began a period of their life of traveling to the West Coast for just less than half the year. Gary helped them purchase a condo in Solana Beach, and Bob and dog Leprechaun have helped them keep it occupied.

Ralph was a life-long learner. He was always curious and inquisitive. He had a fascination with airplanes and flying – he flew and executed over 200 take-offs and landings with an instructor. Ralph would regularly engage people in topics of their interests, rather than his own. He was always alert and thinking about others, and about safety. If he were a passenger in your vehicle – he was watching the road as much/or more than you – and he would be quick to teach a lesson on keeping a safe distance from the car in front of you – "the simplest way to avoid preventable accidents." (Must've had something to do with physics!)

"Ralph would regularly engage people in topics of their interests, rather than his own."

About 18 months ago, Ralph and Edie went from their home in Cedar Falls, Iowa, to visit Deb and Steve in Ames, Iowa – and then one health concern/crisis after another prevented their returning home. They were given expert, steady, and consistent loving care by Deb and Steve all the way through numerous doctor visits, hospital stays, and Ralph's bout with cancer.

On the day of his death, Ralph was surrounded by his wife and 5 adult children, all attending to him and showing their love and concern.

Ralph was a wonderful man with a brilliant sense of humor, a sincere love of others, and a great passion for life.

He will be greatly missed by his dear wife Edith, his 5 children and their spouses, his 9 grandchildren, and his 24 great-grandchildren, extended family, students, and many friends.

May he rest in peace.

IN MEMORIAM

Randy Dumse

Randy Dumse, UNI Physics alumnus and Physics Department Advisory Board member, passed away in November 2020. Here is Randy in his own words several years ago.

I graduated from UNI with a B.A. Physics in 1975. My first job out of UNI: Commissioned Officer in the U.S. Navy. I am currently President/ Founder of New Micros, Inc.

New Micros, Inc. is a small electronics/ computer manufacturer. We get involved in an incredible range of activities, including making robots for museums (recently served the Queen of Jordan) and high profile opportunities. We have worked for Panavision on their movie crane, going to Oprah's set to update her crane. I've also been involved in deep ocean probes, spaceshots, robots, R&D of many kinds, the entertainment industry, and automotive applications.

I found Physics to be fascinating, a profession for prediction of the future, and knowing the most reliably possible about "what's going to happen next" and also on ways things seeming impossible to others fell open to me.

To be a physics major to me is to be a "natural philosopher" in the old sense of the word. To love to learn the nature of things, physics being the deepest understanding we have.

UNI Physics gave me a wonderful background for my diverse life paths.

One thing you'll hear over and over out in the commercial world, "Oh, you did Physics? Well you can probably do anything then."

There is an admirable glory to having been a physics major which commands respect. Yes, sometimes we're thought of as nerdy or brainiacs, but we're never thought of as less than capable.

UNI, in general, I found to be a very nurturing school, small enough to be intimate, but large enough to have offerings beyond just my major. Besides my great physics education, many of the courses I took as electives came to color and enable my life in ways I couldn't begin to see when I was there.

For instance, it was nice to have had China Studies when years later I actually found myself in China. Some French I learned from a girlfriend majoring in it came to serve me when I was Overseas Diplomacy Officer arriving with my ship in Ville French on the French Riviera.

When in school, I had not the vision to imagine I'd ever travel to such exotic places. Another elective, "Muzzle Loading: Historical Significance and Modern Sport" really mattered when I became Gunnery Officer USS Dewey, and won the title: "Top Gun - Sixth Fleet".

Then, I earned a fortune with things I learned in my Math minor and my work study at the Computer Center. I was well served by UNI in many regards, importantly, beyond my provincial vision, which had very narrow horizons, in preparation for my wider world to come.

NEW PHYSICS

Quantum Tunneling Is Not Instantaneous

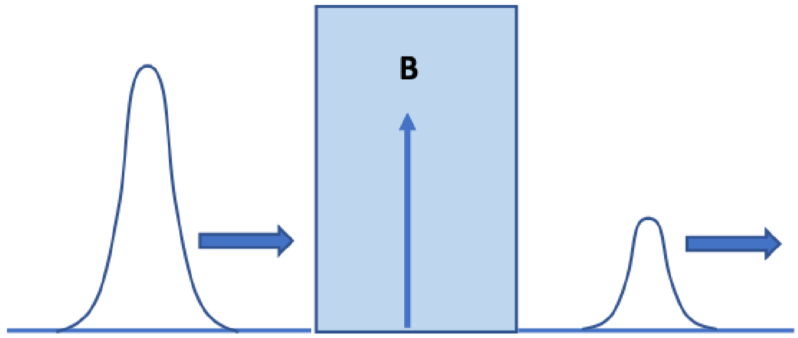


Photo above: Tunneling through a barrier

Many of you undoubtedly remember your first encounter with the concept of quantum tunneling, which likely occurred in the Modern Physics course at UNI. Quantum tunneling is one of those almost magical things that are strewn about as one navigates the quantum wonderland. Tunneling occurs when a quantum particle with a certain fixed value of total mechanical energy makes it from one side of a potential-energy barrier to the other, despite the fact that the maximum energy ("height") of the barrier is greater than the energy of the particle. It's as if a roller coaster that doesn't have enough kinetic energy to get over a hill somehow makes it to the other side without a lift. The coaster obviously couldn't get over the hill, so it must have "tunneled" through the hill. Though roller coaster tunneling is uncommon (i.e., has not been and will never be observed), quantum particles like electrons tunnel all the time. In fact, a scanning tunneling microscope (STM), which operates on the basis of quantum tunneling of electrons, is housed in Andy Stollenwerk's lab in the UNI Physics Department.

So what's going on during tunneling? Is it even appropriate to talk about "during" in this case? After all, within the barrier, the potential energy of the particle exceeds the total energy (kinetic plus potential), which is impossible in good old Newtonian physics. Quantum mechanics rejects this certitude and predicts a non-zero probability for the particle to be inside the barrier. This probability decays exponentially with distance, but is clearly not zero at the other side of a barrier of finite width. So, quantum mechanics tells us that we should expect to observe the particle on the other side of the barrier, but it doesn't really enlighten us about what takes place in transit. All we really know is that the particle's wave function, whose amplitude is related to the probability of finding the particle at a given position, decays exponentially within the barrier. This should make you a bit queasy because when the particle is inside the barrier, the energy does not add up. Literally. Well then, maybe quantum tunneling is instantaneous to avoid misbehavior of the energy.

Aephraim Steinberg and colleagues at the University of Toronto recently performed an experiment to measure quantum tunneling time. It should be mentioned that there have been many preceding experiments that have measured delay times for the traversal of a barrier by photons. There have also been others that have produced results consistent with zero delay time; however, the delay in such experiments is not the same as the tunneling time. Now, experiments with light have to contend with extremely small delay times, of the order of attoseconds (10^{-18}s). Thus, Steinberg and his team set out to conduct an experiment in which the time scale of any traversal time was much greater. They used rubidium-87 atoms cooled to form a Bose-Einstein condensate, in which all the atoms are in a single coherent state. The atoms tunneled through a 1.3 micron-wide optical barrier, which consisted of blue laser light at a wavelength detuned from a transition (resonance) in ^{87}Rb. This detuning produced the atomic-dipole force responsible for a repulsive barrier. The other critical piece of the experiment was the presence of a weak magnetic field inside the barrier. This caused the nuclear magnetic moment (spin) of an atom to precess, like a top in a gravitational field. The magnetic field must be weak in order to avoid significant disturbance of the tunneling particle. The average precession angle is then directly related to the tunneling time. The Toronto group measured a traversal time of 0.61 ± 0.07 milliseconds, which is decidedly not zero. The experimental data are in excellent agreement with time-dependent Schrodinger equation simulations. As a bonus, the team also showed that the lower the energy of the particle (i.e., the greater the negative difference between the total energy and the potential energy in the barrier), the smaller the tunneling time. Please see the reference for details.

Ramón Ramos, David Spierings , Isabelle Racicot and Aephraim M. Steinberg, Nature 583, 529 (2020)

University of Northern Iowa

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

ALUMNI INFO REQUEST

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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)_________________

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