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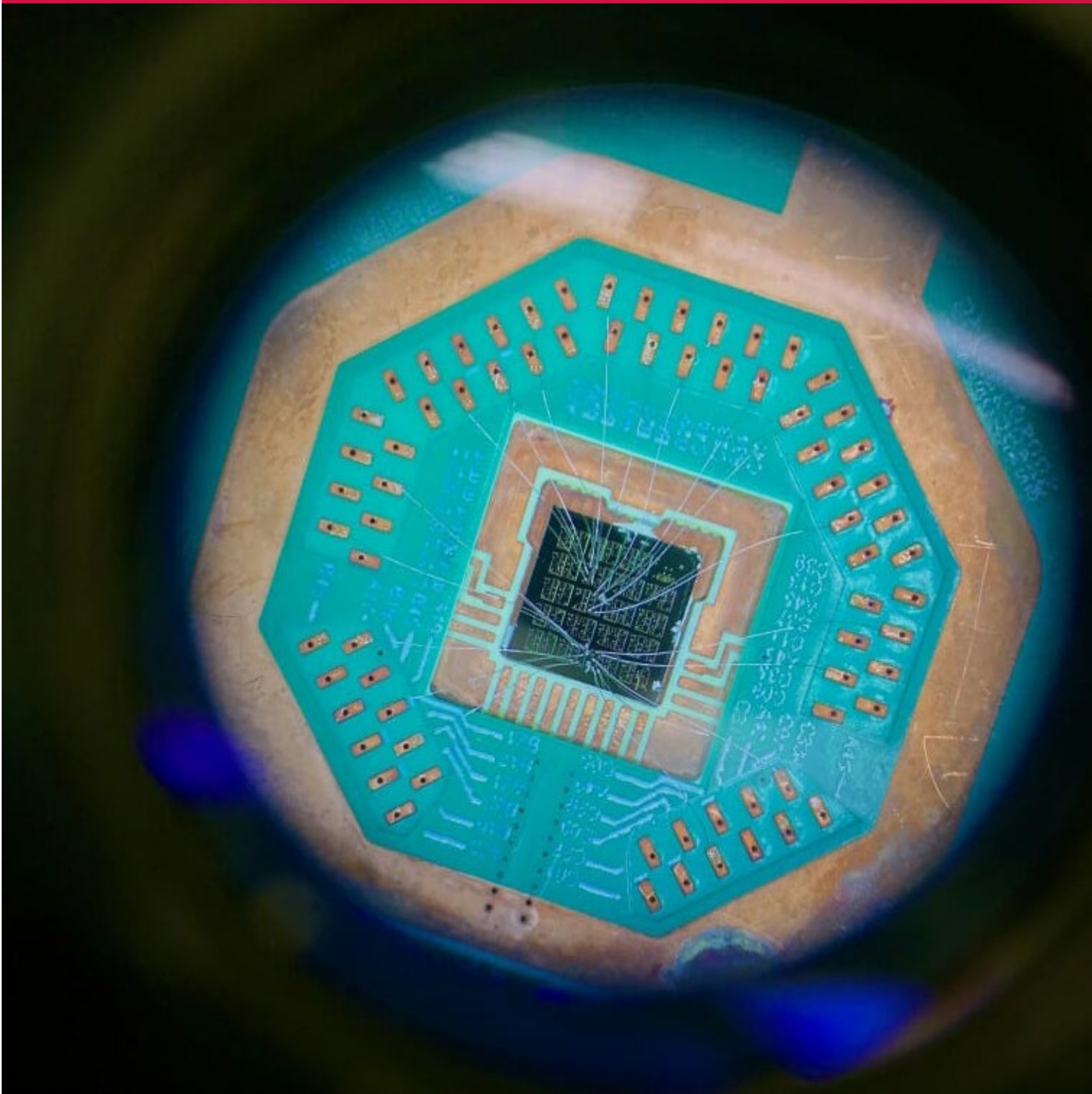

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On the Cover

UW–Madison graduate student Ben Harpt submitted this photo — one of 13 winning entries — to UW–Madison's 2022 Cool Science Image contest. Viewed through the eyepiece of a microscope, aluminum wires one-third the diameter of a human hair connect superconducting devices to a microchip. During experiments, the microchip is cooled to -460 degrees Fahrenheit (just one-hundredth of a degree above absolute zero) to explore the laws of quantum physics and test nanotechnology for quantum computing.

Stay Connected!

Please continue to send us your professional and personal news! We will be happy to include updates from alumni and friends in The Wisconsin Physicist. Send updates to news@physics.wisc.edu or fill out our online form at physics.wisc.edu/alumni-update

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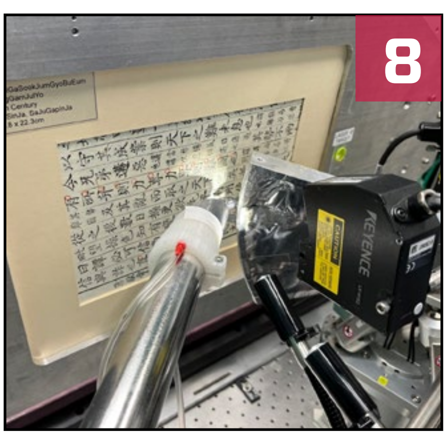


GREETINGS FROM THE CHAIR

Dear Alumni and Friends,

It has been a year of tremendous activity, change, and renewal in our university and especially in our Department of Physics.

Together we welcomed the largest incoming undergraduate class in the university's history. Many of those students are enrolling in physics, either as undergraduate majors, or to build the vital foundation for which physics is so fundamental a part. Speaking of majors, our department graduated 66 physics majors this year, and as of January we now will be offering our primary entry course for new majors, Physics 247, in both Fall and Spring semesters.

Not to be outdone, our PhD program welcomed 43 new graduate students this year in every area of our very broad department. And as the Masters of Physics-Quantum Computing program enters its fourth year, it has the largest enrollment ever, with 22 students taking courses and working on independent research projects.

This past year also saw the return of the in-person The Wonders of Physics annual show. Together with the Physics Fair, it filled Chamberlin Hall with citizens of our state of all ages, enjoying and learning physics with the enthusiastic help of a host of volunteers.

Physics had a very successful year in faculty hiring, and we will welcome two new assistant professors in January 2023. Professor Roman Kuzmin, a quantum condensed matter experimentalist, joins us as the Dunson Cheng Assistant Professor of Physics. And Professor Ilya Esterlis joins us in the area of condensed matter theory. We also welcomed (back) high energy physicist and data scientist Kyle Cranmer, PhD '05, both to our faculty and as the inaugural Director of the American Family Data Science Institute.

Faculty hiring often comes with faculty retiring, and this year we celebrated the highly productive career of Professor Jim Lawler, MS '74 PhD '78. Lawler is an atomic, molecular & optical physicist whose research focused on developing and applying laser spectroscopic techniques for determining accurate absolute atomic transition probabilities. He served as department chair from 1994-97 and won numerous awards throughout his career, including being named a Fellow of the American Physical Society and winning the 2017 Laboratory Astrophysics Prize of the American Astronomical Society.

The department also said farewell to emeritus professor Bernice Durand, who passed away in February. Durand was one of the first two female professors in the department. In addition to her research efforts on symmetry relations in algebra and physics and the phenomenology of high-energy interactions at large particle accelerators, Durand was known across campus as a leader in gender equity. In her honor, the Physics Board of Visitors led the creation of the Bernice Durand Faculty Fellowship.

With our growing number of majors and students taking introductory physics, we have made key additions to our department staff. Josh Weber, PhD '14 has joined us as the Physics 201/202 course coordinator. He joins a team of course coordinators for all the large introductory physics classes that is working together to maximize the student experience in these important classes. Evan Heintz, PhD '22 is our department's new staff undergraduate advisor, and is working in collaboration with our faculty advisors to support physics majors in all aspects during their time with us. As of January 2022, Elizabeth Baldridge is the graduate program coordinator for MSPQC program and supports students both during their time here and in finding internships and post-graduate opportunities. In support of students in four of our large, introductory physics courses, instructor Laura Ocampo Alzate has joined the Physics Learning Center.

Physics faculty received a host of external awards this year. Professors Mark Rzchowski and Alex Levchenko were elected Fellows of the American Physical Society; Levchenko was additionally awarded a Humboldt Fellowship, with the support of which he will visit the Max Planck Institute for Solid State Research in Stuttgart, Germany. Professor Ellen Zweibel was awarded the 2022 Catherine Wolfe Bruce Gold Medal by the Astronomical Society of the Pacific, the group's most prestigious award. Assistant Professor Keith Bechtol was selected to the Department of Energy's Early Career Research Program, supporting him and his research team as they work on commissioning the Vera C. Rubin Observatory in preparation for the Legacy Survey of Space and Time. And Shimon Kolkowitz, in addition to being promoted to Associate Professor with tenure, was awarded a Sloan Foundation Fellowship, a highly prestigious award given to promising researchers in the early stages of their career.

Our faculty also earned University honors, including Mark Saffman, now the Johannes Rydberg Professor of Physics, receiving a WARF named professorship and Thad Walker being named a Vilas Distinguished Achievement Professorship. WARF Research Forward awards went to Professors Victor Brar, Moritz Münchmeyer, and Gary Shiu, and Brian Rebel was promoted to full Professor.

Our fantastic students are similarly earning awards in honor of their many academic achievements. PhD student Margaret Fortman was one of only four students nationally to receive a 2022 Google quantum computing fellowship. Graduate student Shu Tian Eu was selected as an L&S Teaching Mentor. Undergraduate physics major Katie Harrison was named an Open Quantum Initiative Fellow. And undergraduate students Elyse Incha, Haoyi Ji, Daniel Lewis, and Nico Ranabhat earned Hilldale Awards to conduct research in our department.

Our department launched two Fellows programs this year. The first, the Thaxton Fellows, was started under the leadership of Professor Keith Bechtol to provide more equitable access to physics research experiences for undergraduates. Two students, Alex Tellez (working with Professor Justin Vandenbroucke) and Ella Sabo (working with Professor Dan McCammon), began their research this year. Second, 15 of our current first-year PhD students are in the inaugural class of the Wonders of Physics Outreach Fellows. This program supports students who are interested in and committed to conducting physics outreach.

Sharing the joy and learning of physics has a rich and storied history in our department. We host the 103-year-old Ingersoll Physics Museum. With K-12 schools back in person and field trips resuming, the museum is once again an educational destination for future scientists. Thanks to a Wisconsin Idea Collaboration grant, we have also installed two new "physics of climate change" exhibits. Our department's outreach team has updated displays to make them ever more user friendly, and our thriving docents program ensures most visiting groups are guided through hands-on learning.

For last word on the coming year I must return to The Wonders of Physics. Haddie McLean brings the traveling show to K-12 students in every corner of the state. This February in Chamberlin Hall, we will celebrate the 40th The Wonders of Physics series of shows hosted here in our own department. Professor Clint Sprott has not yet announced what he has up his sleeve for this very special year, but we do know that the shows will be livestreamed, and we hope you can join either in person or online this coming February. The latest information is always at wonders.physics.wisc.edu.

On, Wisconsin!

— Mark Eriksson, Department Chair and John Bardeen Professor of Physics

FACULTY UPDATES

In 2022, we welcomed three new faculty, wished one a happy retirement, and lost one dear colleague

Welcome, Professor Kyle Cranmer!

Professor of Physics and the David R. Anderson Director of the American Family Data Science Institute

By Cris Carusi, Data Science Institute


Prof. Kyle Cranmer

Kyle Cranmer joined the American Family Insurance Data Science Institute in July 2022 as the David R. Anderson Director. He is a professor in the Physics Department with affiliate appointments in Computer Sciences and Statistics.

What is your educational/professional background?

I did my undergrad in math and physics at Rice University. I got my PhD right here in Madison. I was a fellow at Brookhaven National Lab before I moved to New York University, where I was a professor of physics for 15 years. I was also the executive director of the Moore-Sloan Data Science Environment, where we worked to understand the institutional changes necessary to establish data science in academia.

How did you get into your current field of research?

The first part of my professional career was focused on particle physics and the search for the Higgs boson, which we discovered in 2012. That was right around the time deep learning was taking off, and I started thinking about how we could apply the advances we were seeing in machine learning (ML) to the sciences. I think of my particle physics research as my muse for coming up with new methodological techniques. I think about how the problems manifest themselves in the context of physics, which I know really well, and then I abstract the solutions I come up with to other fields.

What are the main goals of your research program?

On the physics side, there are two strategies happening at the Large Hadron Collider. One of them is to make very precise measurements as a way of revealing some kind of crack in our understanding. The other is to look at the data in a more open-minded way. Initially, people at the LHC were looking for evidence for very specific theories, and we haven't found it. Reframing how we go about doing particle physics on the largest data set in science is interesting. On the machine learning side, I'm interested in how we can use ML techniques and still maintain some notion of interpretability and scientific understanding. I'm also interested in combining causality with machine learning.

What's one thing you hope students who take a class with you will come away with?

As we pile the tower of knowledge higher and higher, it's sometimes easy to forget that the foundational questions are timeless. Those foundations you use to frame the problem are often the most important, and all the stuff built on top can be revisited as technology moves forward.

What are you most enjoying about working here?

I'm getting to know a lot of amazing people from parts of the university that I didn't know when I was a graduate student. It's exciting to think about all the ways we can collaborate and do something amazing. The potential is huge.

"It's sometimes easy to forget that the foundational questions are timeless. Those foundations you use to frame the problem are often the most important."

Do you share your work and expertise with the public through social media? If so, which channels do you use?

I've done videos on YouTube, but my primary mechanism for engaging the public in terms of social media is Twitter (@kylecranmer). I have over 13,000 followers.

What's something interesting about your area of expertise you can share that will make us sound smarter at parties?

Now that we know the mass of the Higgs particle, it's possible the universe is unstable and could transition into some other phase that would destroy all life. But if that happens, it will fly through us at the speed of light, and we won't even know it happened or be able to warn anyone.

What are your hobbies and other interests?

I love music a lot. I love nature: going on hikes, star gazing and camping. I prioritize spending time with my family.

Welcome, Professor Ilya Esterlis!

Assistant Professor of Physics

By Sarah Perdue, Department of Physics

Prof. Ilya Esterlis

When Lake Mendota freezes over in the winter and thaws in the spring, those water/ice phase transitions might seem mundane. But, says new assistant professor of physics Ilya Esterlis, interesting things happen during phase transitions, and commonalities exist between phase transitions of any matter.

"That's very surprising and strange sounding, but it turns out that there's a very general framework in which to understand [these commonalities]," Esterlis says. "It's this notion of universality, and by studying phase transitions you're simultaneously studying a very broad class of materials."

Esterlis, a condensed matter theorist whose research focuses on materials and phase transitions, joins the department in January 2023. He is currently a postdoctoral fellow at Harvard.

Can you please give an overview of your research?

I am a condensed matter theorist, so I study materials, and in particular I try to classify different phases of matter and the phase transitions between those phases of matter. I'm mostly interested in electronic systems, where you have a large macroscopic number of interacting electrons and are trying to understand the kind of phenomena that can emerge when you have that large number of degrees of freedom interacting with one another. And a lot of these things are motivated by experiments, though not all of them. There are some more academic questions that I'm interested in investigating and they're a bit more formal. But I'm also motivated by interesting things that are happening in the lab. Part of my work is not only trying to characterize and understand phases of matter, but also trying to propose ways that different phases could be detected experimentally, how they would manifest themselves in different experimental signatures.

"If you had all the freedom in the world, how would you build the best superconductor that exists to high temperatures and under normal laboratory conditions?"

I'm also interested in superconductivity. My PhD work focused a lot on trying to understand the optimal conditions for making superconductors — if you could have every knob at your disposal, what would you do to optimize them? Optimize in this case means: make superconductors that exist at as high of a temperature as possible. Superconductivity is typically a low temperature phenomenon, so there's a holy grail in condensed matter physics trying to make higher temperature superconductors. Part of my work has been organized around trying to understand what would be even in principle the optimal route towards achieving higher temperature superconductors.

Once you're in Madison, what are one or two research projects you and your group will focus on?

I will focus a good amount of my research efforts on studying superconductivity, continuing this line of investigation into what the optimal conditions for superconductors are. If you had all the freedom in the world, how would you build the best superconductor that exists to high temperatures and under normal laboratory conditions? Not under extreme, unrealistic conditions but in an everyday parameter regime. And that involves understanding the superconducting state itself. Superconductors are a phase of matter that is distinct from, say, a metal, which is also a good conductor but not a superconductor. But oftentimes to understand superconductors better, one has to understand the state from which they came. That is to say, you take a metal and you cool it down to low temperatures and it goes from being a good conductor to a superconductor. To understand that superconductor, it's often helpful to understand the metal from which it came at higher temperature. And sometimes those metals can be conventional, like copper wires, but sometimes they can be very unconventional metals and strange for various reasons. One open question is: what is the interplay between superconductivity and unusual metals? If you take a high temperature unusual metal, what is the kind of superconductor that it turns into at lower temperature? And unusual in this context means that it has some properties that are not typical to conventional metals. For instance, there are predictions for how resistance changes with temperature in a conventional metal but unusual metals have rather different resistance behaviors.

What is your favorite element and/or elementary particle?

Helium is remarkable in that it has a number of unusual properties. For instance, if you cool it down to zero temperature it does not crystallize, it remains a liquid. That's solely due to quantum mechanics, which is kind of an incredible thing. If you do make it crystallize by applying pressure, then that solid itself also has very interesting properties.

And my favorite elementary particle is the anyon. It's not elementary, say, in the sense of electrons or quarks. But it's this really remarkable thing that happens in condensed matter systems where if you take a macroscopic number of electrons and you subject them to a very large magnetic field, then the behavior of the system, as viewed on macroscopic scales, does not look like the behavior of electrons, it really looks like the behavior of particles called anyons that have fractional electric charge. So they are elementary in condensed matter physics.

What hobbies and interests do you have?

I really love to play music, guitar specifically. And I have two small kids, two daughters, and I just like hanging out with them.

Welcome, Professor Roman Kuzmin!

The Dunson K. Cheng Assistant Professor of Physics

By Sarah Perdue, Department of Physics

Prof. Roman Kuzmin

In the modern, cutting-edge field of quantum computing, it can be a bit puzzling to hear a researcher relate their work to low-tech slide rules. Yet that is exactly the analogy that Roman Kuzmin uses to describe one of his research goals, creating quantum simulators to model various materials. He also studies superconducting qubits and ways to increase coherence in this class of quantum computer.

Kuzmin, a quantum information and condensed matter scientist, will join the department as the Dunson Cheng Assistant Professor of Physics in January 2023. He is currently a research scientist at the University of Maryland's Joint Quantum Institute in College Park, MD.

Can you please give an overview of your research?

My main fields are quantum information and condensed matter physics. For example, one of my interests is to solve complicated condensed matter problems using new techniques and materials which quantum information science developed. Also, it works in the other direction. I am also trying to improve materials which are used in quantum information. I work in the subfield of superconducting circuits. There are several different directions in quantum information, and the physics department at Wisconsin has many of them already, so I will complement work in the department.

(L-R) Susan Anderson, Prof. Roman Kuzmin, L&S Dean Eric Wilcots, Physics Chair Mark Eriksson, and Roberta Eriksson at the L&S Investiture Ceremony in September 2022.

Once you're in Madison and your lab is up and running, what are the first one or two big things you want to focus your energy on?

One is in quantum information and quantum computing. So, qubits are artificial atoms or building blocks of a quantum computer. I'm simplifying it, of course, but there are environments which try to destroy coherence. In order to scale up those qubits and make quantum computers larger and larger — because that's what you need eventually to solve anything, to do something useful with them — you need to mitigate decoherence processes which basically prevent qubits from working long enough. So, I will look at the sources of those decoherence processes and try to make qubits live and be coherent longer.

A second project is more on the condensed matter part. I will build very large circuits out of those Josephson junctions, inductors and capacitors, and such large circuits behave like some many-body objects. It creates a problem which is very hard to solve because it contains many parts, and these parts interact with each other such that the problem is much more complicated than just the sum of those parts.

What are some applications of your work?

Of course this work is interesting for developing theory and understanding our world. But the application, for example for the many-body system I just described, it's called the quantum impurity. One of my goals is to use this to create a simulator which can potentially model some useful material. It's like if you have a quantum computer, you can write a program and it will solve something for you. A slide rule is a physical device that allows you to do complicated, logarithmic calculations, but it's designed to do only this one calculation. I'm creating kind of a quantum slide rule.

What is your favorite element and/or elementary particle?

I have my favorite circuit element: Josephson junction. *(editor's note: the question did not specify atomic element, so we appreciate this clever answer!)*. And for elementary particle, the photon, especially microwave photons, because that's what I use in these circuits to do simulations. They're very versatile and they're just cool.

What hobbies and interests do you have?

I like reading, traveling, and juggling.

Congrats to Professor Lawler on his retirement!

By Sarah Perdue

After 42 years on the UW–Madison faculty, Jim Lawler, the Arthur and Aurelia Schawlow Professor of Physics, retired this past May. Lawler is an atomic, molecular & optical physicist with a focus on developing and applying laser spectroscopic techniques for determining accurate absolute atomic transition probabilities.

"What we've really done gradually over four-plus decades is make atomic spectroscopy more quantitative so that people can use it to really learn the detailed physics and chemistry of the remote universe," Lawler says.

Lawler received his MS ('74) and PhD ('78) from this department, studying with now-professor emeritus Wilmer Anderson. He was a research associate at Stanford University and returned to UW–Madison as an assistant professor in 1980.

"There was a little bit of a disadvantage to come back to a place where I had recently been as a student," Lawler says. "But I knew I would get extremely good graduate students and I would have access to a lot of infrastructure, and that combination really drew me back."

He had extremely good graduate students and postdocs. Lawler supervised 26 PhD students and 10 terminal MS students. Those students and postdocs have gone on to prestigious National Research Council Fellowships, group lead positions at major companies, and tenured professorships, amongst many others.

Jim Lawler in his research lab

Lawler served as department chair from 1994-1997. He also accumulated numerous awards and honors over his distinguished career. He is a fellow of the American Physical Society, the Optical Society of America, the U.K. Institute of Physics, and in 2020 he was elected a Legacy Fellow of the inaugural class of American Astronomical Society Fellows. He won the 1992 W. P. Allis Prize of the American Physical Society and the 1995 Penning Award from the International Union of Pure and Applied Physics for research in plasma physics, the two highest National and International Awards in the field of Low Temperature Plasma Physics. In 2017, he won Laboratory Astrophysics Prize of the American Astronomical Society for research in spectroscopy.

Remembering Professor Bernice Durand

By Sarah Perdue and Department Archives

Bernice Durand, Professor Emerita and one of the first two female professors in the UW–Madison Department of Physics, passed away February 7, 2022.

Durand was a theoretical physicist who specialized in particle theory and mathematical physics. Her research was on symmetry relations in algebra and physics, plus the phenomenology of high-energy interactions at large particle accelerators. She earned her BS and PhD degrees in physics from Iowa State University. In 1970, she started at UW–Madison as a research associate and lecturer and joined the faculty in 1977, where she directed nine PhD and three MS students.

Bernice Durand

As the first Associate Vice Chancellor for Diversity & Climate, Professor Durand provided leadership to ensure that faculty, staff, and student diversity issues including race, ethnicity, gender, sexual preference, and classroom and general campus workplace climate issues be addressed, and that search committees for non-classified staff be trained in broadening the pool of applicants and eliminating implicit bias. Durand co-directed a grant from the Alfred P. Sloan Foundation to the UW System designed to create more equity, flexibility and career options for faculty and academic staff. She was also a member of the leadership team of the Women in Science and Engineering Leadership Institute sponsored by the National Science Foundation to increase the participation and status of women in science.

A recipient of the Chancellor's Award for Outstanding Teaching, Professor Durand taught courses at all levels. In the mid-1990s, she used technological and pedagogical techniques in her teaching, such as broadcasting her modern physics for non-scientists course on public television with web-based coursework, and pioneering one of two early versions of MOOCs (massive open online courses) on campus.

In 2018, the department's Board of Visitors sought to create an endowed faculty fund in honor of Durand. Thanks to generous support from several Board of Visitors members and Bernice's husband, Professor Emeritus Randy Durand, the Bernice Durand Faculty Fellowship was established in 2021. The Department plans to use the Durand Faculty Fellowship to support a professor in the department who will expand efforts to create a more diversified faculty.

RESEARCH HIGHLIGHTS

A look back at research from across the department in 2022

X(ray) marks the spot in elemental analysis of 15th century printing press methods

By Sarah Perdue, Department of Physics

In 15th century Germany, Johannes Gutenberg developed a printing press, a machine that allowed for mass production of texts. It is considered by many to be one of the most significant technological advancements of the last millennium.

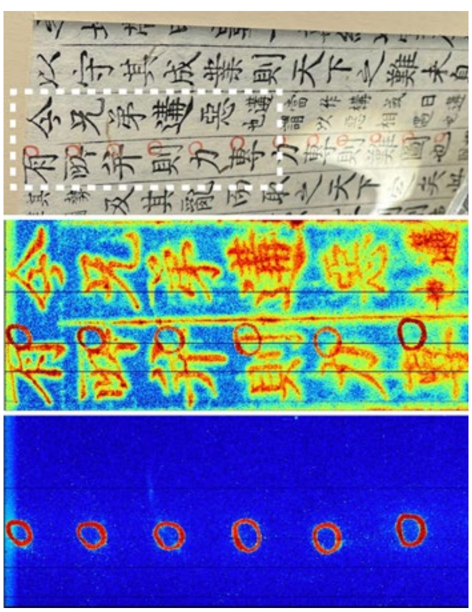
Though Gutenberg often receives credit as the inventor of the printing press, sometime earlier, roughly 5,000 miles away, Koreans had already developed a movable-type printing press.

There is no question that East Asians were first. There is also no question that Gutenberg's invention in Europe had a far greater impact.

"What is not known is whether Gutenberg knew about the Korean printing or not. And if we could shed light on that question, that would be earth shattering," says professor Uwe Bergmann who, with graduate student Minhal Gardezi, is part of a large, interdisciplinary team that is analyzing historical texts.

He adds: "But even if we don't, we can learn a lot about early printing methods, and that will already be a big insight."

These texts include pages from a Gutenberg bible and Confucian texts, and they're helping investigate these questions. The team includes 15th century Korean texts experts, Gutenberg experts, paper experts, ink experts and many more.



(top panel) A photograph of a scanned Korean text. The white dotted box indicates the areas shown in the middle and bottom panels. Each element produces a unique X-ray fluorescence. After scanning the text, the researchers applied filters for the known XRF patterns of different elements and created a color-coded heat-map (middle and bottom) of their abundance, from lowest (blue) to highest (red). An element found in only small quantities is in the red circles in the bottom panel.

Minhal Gardezi (left) and Uwe Bergmann prepare a leaf of the Gutenberg Bible for scanning.

How did two physicists end up participating in a seemingly very non-physics cultural heritage project? Bergmann had previously worked on other historical text analyses, where he pioneered the application of a technique known as X-ray fluorescence (XRF) imaging.

In XRF imaging, a synchrotron sends an intense and very small X-ray beam — about the diameter of a human hair — at a page of text. The beam excites electrons in the atoms that make up the text, requiring another electron to fill in the space left by the first. The second electron loses energy which is released as a small flash of light. A detector placed strategically nearby picks up that light, or its X-ray fluorescence, and measures both its intensity and the part of the light spectrum to which it belongs.

"Every single element on the periodic table emits an X-ray fluorescence spectrum that is unique to that atom when hit with a high-energy X-ray. Based on its 'color,' we know exactly which element is present," says Gardezi. "It's a very high-precision instrument that tells you all the elements that are at every location in a sample."

With this information, researchers can effectively create an elemental map of the document. By rapidly scanning a page across the X-ray beam, they can create a record of the XRF spectrum at each pixel. One page can produce several million XRF spectra.

This summer, Bergmann and Gardezi were part of a team that used XRF scanning at the SLAC National Accelerator Laboratory in California to produce elemental maps of several large areas from original pages of a first-edition, 42-line Gutenberg Bible (dating back to 1450 to 1455 A.D.) and from Korean texts dating back to the early part of that century.

They scanned the texts at a rate of around one pixel every 10 milliseconds, then filtered the data by elemental signature, providing high-resolution maps of which elements are present and in what relative quantities.

In a way, the work is like digging for treasure from an old map — Gardezi says the researchers do not know exactly what they are looking for, but they are most interested in the unexpected.

For example, she recently presented early results of scans to the team, to demonstrate the approach had worked and that the researchers could separate out different elements. It turns out this isn't what the team found most interesting.

"Instead, these scholars spent 15-to-20 minutes talking about, 'Why is [this element] present?' and coming up with hypotheses," Gardezi says. "As physicists, we wouldn't even recognize if something is surprising or not. It's really this interdisciplinary aspect that tells us what to look for, what the smoking gun is."

As more questions arise based on the elemental analyses, Bergmann and Gardezi will help guide the team to address those questions quantitatively. They are already planning to recreate some early printings in the lab — with known types, papers and inks — then compare these XRF scans with the originals.

> **"It's really this interdisciplinary aspect that tells us what to look for, what the smoking gun is."**
>
> – Minhal Gardezi

The research may never definitively determine if Gutenberg knew about the Korean presses or if he developed his press independently. But without access to the original presses themselves, these texts hold the only clues to understanding the nature of these transformative machines.

"The more you read about it, the more you learn that there is less certainty about several things related to early printing presses," Bergmann says. "Maybe this technique will allow us to view these prints as a time capsule and gain invaluable insight into this watershed moment in human history."

IceCube study reveals neutrinos emanating from galactic neighbor with a gigantic black hole

By Alisa King-Klemperer, IceCube

On Earth, billions of subatomic particles called neutrinos pass through us every second, but we never notice because they rarely interact with matter. Because of this, neutrinos can travel straight paths over vast distances unimpeded, carrying information about their cosmic origins.

Although most of these aptly named "ghost" particles detected on Earth originate from the Sun or our own atmosphere, some neutrinos come from the cosmos, far beyond our galaxy. These neutrinos, called astrophysical neutrinos, can provide valuable insight into some of the most powerful objects in the universe.

For the first time, an international team of scientists has found evidence of high-energy astrophysical neutrinos emanating from the galaxy NGC 1068 in the constellation Cetus.

The detection was made by the National Science Foundation-supported IceCube Neutrino Observatory, a 1-billion-ton

At a distance of 47 light-years, the spiral galaxy NGC 1068 is a relatively close neighbor to our Milky Way.

neutrino telescope made of scientific instruments and ice situated 1.5-2.5 kilometers below the surface at the South Pole.

These new results were published in the journal *Science*.

"One neutrino can single out a source. But only an observation with multiple neutrinos will reveal the obscured core of the most energetic cosmic objects," says Francis Halzen, a University of Wisconsin–Madison professor of physics and principal investigator of the IceCube project. "IceCube has accumulated some 80 neutrinos of teraelectronvolt energy from NGC 1068, which are not yet enough to answer all our questions, but they definitely are the next big step toward the realization of neutrino astronomy."

For the full story, visit go.wisc.edu/75qoft

Training students at the interface of high energy physics and computer science

By Sarah Perdue, Department of Physics

To truly understand our physical world, scientists look to the small, subatomic particles that make up everything. Particle physics generally falls under the discipline of high energy physics (HEP), where higher and higher energy collisions — tens of teraelectronvolts, or about ten trillion times the energy of visible light — lead to the detection and characterization of particles and how they interact.

These collisions also lead to the accumulation of inordinate amounts of data, and HEP is increasingly becoming a field where researchers must be experts in both particle physics and advanced computing technologies. HEP graduate students, however, rarely enter graduate school with backgrounds in both fields.

Physicists from UW–Madison, Princeton University, and the University of Massachusetts-Amherst are looking to address the science goals of the HEP experiments by training the next generation of software and computing experts with a 5-year, ~$4 million grant from the U.S. Department of Energy (DOE) Office of Science, known as Training to Advance Computational High Energy Physics in the Exascale Era, or TAC-HEP.

"The exascale era is upon us in HEP and the complexity, computational needs and data volumes of current and future HEP experiments will increase dramatically over the next few years. A paradigm shift in software and computing is needed to tackle the data onslaught," says Tulika Bose, a physics professor at UW–Madison and TAC-HEP principal investigator.

These servers in Chamberlin Hall are part of the massive global computing grid required to analyze LHC data from CERN.

"TAC-HEP will help train a new generation of software and computing experts who can take on this challenge head-on and help maximize the physics reach of the experiments."

At UW–Madison, TAC-HEP will annually fund four-to-six two-year training positions for graduate students working on a computational HEP research project with Bose or physics professors Keith Bechtol, Kevin Black, Kyle Cranmer, Sridhara Dasu, or Brian Rebel. Their research must broadly fit into the categories of high-performance software and algorithms, collaborative software infrastructure, or hardware-software co-design.

TAC-HEP will incorporate targeted coursework and specialized training modules, and will include student professional development including oral and written science communication and cohort-building activities.

For the full story, visit go.wisc.edu/gv291j

Cross-institutional collaboration leads to new control over quantum dot qubits

By Meredith Fore, Chicago Quantum Exchange

Qubits are the building blocks of quantum computers, which have the potential to revolutionize many fields of research by solving problems that classical computers can't. But creating qubits that have the perfect quality necessary for quantum computing can be challenging.

Researchers at the University of Wisconsin–Madison, HRL Laboratories LLC, and University of New South Wales collaborated on a project to better control silicon quantum dot qubits, allowing for higher-quality fabrication and use in wider applications.

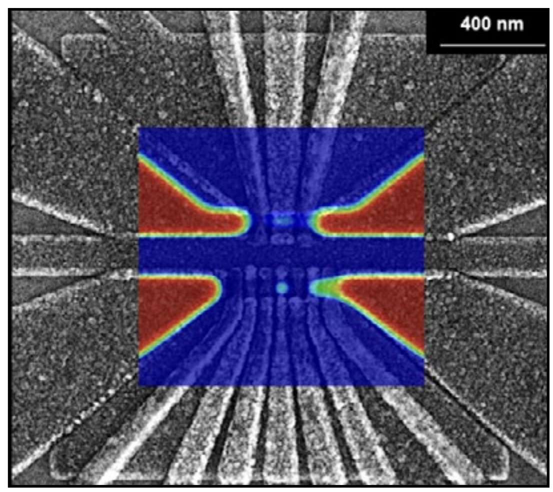
The work was published in Physical Review Letters.

"Consistency is the thing we're after here," says Mark Friesen, Distinguished Scientist of Physics at UW–Madison and author on the paper. "Our claim is that there is actually hope to create a very uniform array of dots that can be used as qubits."

While classical computer bits use electric circuits to represent two possible values (0 and 1), qubits use two quantum states to represent 0 and 1, which allows them to take advantage of quantum phenomena like superposition to do powerful calculations.

Qubits can be constructed in different ways. One way to build a qubit is by fabricating a quantum dot, or a very, very small cage for electrons, formed within a silicon crystal. Unlike qubits made of single atoms, which are all naturally identical, quantum dot qubits are man-made—allowing researchers to customize them to different applications.

But one common wrench in the metaphorical gears of these silicon qubits is competition between different kinds of quantum states. Most qubits use "spin states" to represent 0 and 1, which rely on a uniquely quantum property called spin. But if the qubit has other kinds of quantum states with similar energies, those other states can interfere, making it difficult for scientists to effectively use the qubit.



The electron density inside a silicon quantum device.

In silicon quantum dots, the states that most often compete with the ones needed for computing are "valley states," named for their locations on an energy graph—they exist in the "valleys" of the graph.

To have the most effective quantum dot qubit, the valley states of the dot must be controlled such that they do not interfere with the quantum information-carrying spin states. But the valley states are extremely sensitive; the quantum dots sit on a flat surface, and if there is even one extra atom on the surface underneath the quantum dot, the energies of the valley states change.

The study's authors say these kinds of single-atom defects are pretty much "unavoidable," so they found a way to control the valley states even in the presence of defects. By manipulating the voltage across the dot, the researchers found they could physically move the dot around the surface it sits on.

For the full story, visit go.wisc.edu/3ptnme

Magellanic Stream arcing over Milky Way may be five times closer than previously thought

By Eric Hamilton, University Communications

Our galaxy is not alone. Swirling around the Milky Way are several smaller, dwarf galaxies — the biggest of which are the Small and Large Magellanic Clouds, visible in the night sky of the Southern Hemisphere.

During their dance around the Milky Way over billions of years, the Magellanic Clouds' gravity has ripped from each of them an enormous arc of gas — the Magellanic Stream. The stream helps tell the history of how the Milky Way and its closest galaxies came to be and what their future looks like.

A view of the gas in the Magellanic System as it would appear in the night sky. This image, taken directly from the numerical simulations, has been modified slightly for aesthetics.

New astronomical models developed by scientists at the University of Wisconsin–Madison and the Space Telescope Science Institute recreate the birth of the Magellanic Stream over the last 3.5 billion years. Using the latest data on the structure of the gas, the researchers discovered that the stream may be five times closer to Earth than previously thought.

The findings suggest that the stream may collide with the Milky Way far sooner than expected, helping fuel new star formation in our galaxy.

"The Magellanic Stream origin has been a big mystery for the last 50 years. We proposed a new solution with our models," says Scott Lucchini, a graduate student in physics at UW–Madison and lead author of the paper. "The surprising part was that the models brought the stream much closer to the Milky Way."

The new models also provide a precise prediction of where to find the stream's stars. These stars would have been ripped from their parent galaxies with the rest of the stream's gas, but only a few have been tentatively identified. Future telescope observations might finally spot the stars and confirm the new reconstruction of the stream's origin is correct.

Their work was published in The Astrophysical Journal Letters.

"It's shifting the paradigm of the stream," says Lucchini. "Some have thought the stars are too faint to see because they're too far away. But we now see that the stream is basically at the outer part of the disk of the Milky Way."

For the full story, visit go.wisc.edu/x96h81

Plasmas, patents and progress with WHAM

By Sarah Perdue, Department of Physics

Things are really starting to heat up (pun intended) with the Wisconsin HTS Axisymmetric Mirror, or WHAM.

Nearly three years after the $5 million fusion reactor was announced by the Department of Energy, physics professor Cary Forest and the team at the Wisconsin Plasma Physics Laboratory are close to making plasma. They have also worked with WARF to secure multiple patents and even create a spinoff company.

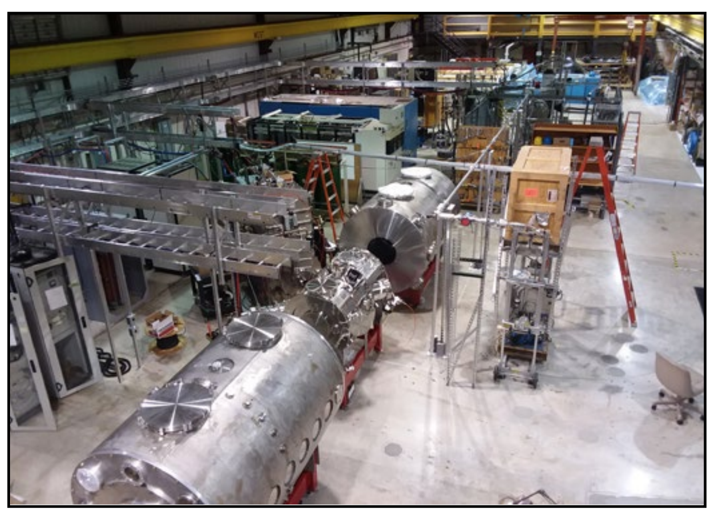
"We're hoping to have our first plasmas in January or February 2023, we're just waiting on the magnets from Commonwealth Fusion Systems," Forest says. "In the meantime, we're continuing to build up the lab."

WHAM leverages major advances in superconducting magnets and plasma heating to pursue commercially viable nuclear fusion power. Since receiving the funding, the team has been busy constructing the device at the Physical Sciences Laboratory in Stoughton and finalizing the installation of all the needed equipment.

"At the same time, the grant also supported a technology-to-market development program, and so we've filed a number of patents with WARF," Forest says. "WARF connected us with Kieran Furlong, a former tech-to-market advisor for the university who helped us develop a business plan."

Furlong is now CEO of Realta Fusion, a spinoff company formed through the WARF development program. The company is in its infancy and has a goal of upgrading WHAM technology to a reactor-grade version.

For a time lapse video of the construction, visit go.wisc.edu/76mjl0



The almost-completed WHAM device, housed in the Physical Sciences Laboratory, is expected to have its first plasma in early 2023.

FACULTY AWARDS & HONORS

From University awards to professional society fellowships, the department once again had many faculty recognized for contributions to their field

Professional Society and Other External Awards & Honors

Mark Rzchowski

Professors Alex Levchenko and Mark Rzchowski were elected 2022 Fellows of the American Physical Society. Levchenko was elected for "broad contributions to the theory of quantum transport in mesoscopic, topological, and superconducting systems." He was nominated by the Division of Condensed Matter Physics. Rzchowski was elected for "pioneering discoveries and understanding of physical principles governing correlated complex materials and interfaces, including superconductors, correlated oxide systems multiferroic systems, and spin currents in noncollinear antiferromagnets." He was nominated by the Division of Materials Physics.

APS Fellowship is a distinct honor signifying recognition by one's professional peers for outstanding contributions to physics. Each year, no more than one half of one percent of the Society's membership is recognized by this honor.

Alex Levchenko

Levchenko was also named a Humboldt Fellow, a program which enables highly-qualified scientists and scholars from abroad to spend time conducting research at a partner university in Germany. He was nominated by the Max Planck Institute for Solid State Research in Stuttgart, where he will be affiliated with the Quantum Many Body Theory Department.

Ellen Zweibel

The Astronomical Society of the Pacific (ASP) has awarded the 2022 Catherine Wolfe Bruce Gold Medal to Professor Ellen Zweibel. It is the most prestigious award given by ASP.

Zweibel, the William L. Kraushaar professor of astronomy and physics at UW–Madison, was recognized for her contributions to the understanding of astrophysical plasmas, especially those associated with the Sun, stars, galaxies, and galaxy clusters. She has also made major contributions in linking plasma characteristics and behaviors observed in laboratories to astrophysical plasma phenomena occurring in the universe.

Professor Shimon Kolkowitz added both a Sloan Fellowship and a National Science Foundation CAREER Award to his slate of early-career achievements.

Sloan Research Fellowships are competitive, prestigious awards given to promising researchers in the early stages of their careers, and Kolkowitz was one of four UW–Madison recipients this year. Each fellow receives $75,000 in research funding from the foundation, which awards Sloan Research Fellowships in eight scientific and technical fields, including physics.

Shimon Kolkowitz

The NSF CAREER award, a five-year, $800,000 in total award, will cover research expenses, graduate student support, and outreach projects based on the research.

Professor Keith Bechtol was selected to the U.S. Department of Energy Office of Science's Early Career Research Program. The funding — around $150,000 per year for five years — will allow Bechtol and his group to first work on commissioning the Vera C. Rubin Observatory in preparation for the Legacy Survey of Space and Time (LSST), then they will transition to data collection and analysis for their cosmology research.

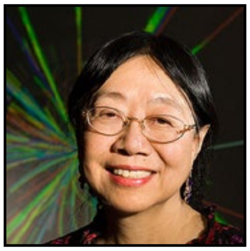
Keith Bechtol

High energy physicist **Professor Sridhara Dasu was named a member of the International Committee for Future Accelerators** (ICFA), a term he'll serve for three years. ICFA was created to facilitate international collaboration in the construction and use of accelerators for high energy physics. The Committee has 16 members, selected primarily from the regions most deeply involved in high-energy physics. Dasu will be representing the United States on the committee.

Sridhara Dasu

Professor Pupa Gilbert's textbook, *Physics in the Arts*, has earned a 2022 Textbook & Academic Authors Association (TAA) "Texty" award for Textbook Excellence. Overall, 13 textbooks received Textbook Excellence Awards, which recognize excellence in current textbooks and learning materials.

Pupa Gilbert



Sau Lan Wu

The International Astronomical Union has honored **Professor Sau Lan Wu by naming a minor planet, 'Saulanwu,'** after her.

The planet 'Saulanwu' (=2005 JE163) was discovered on May 8, 2005 at Mt. Lemmon observatory in southern Arizona by a NASA funded project, the Catalina Sky Survey. It is located in the asteroid belt between Mars and Jupiter, is about two kilometers in diameter, and takes four years to orbit the sun once. This planet is relatively stable, dynamically, and is expected to remain in our cosmos for millions of years to come. Wu was nominated for this honor by astronomer Gregory J. Leonard from the University of Arizona's Department of Planetary Sciences.

UW–Madison Awards & Honors

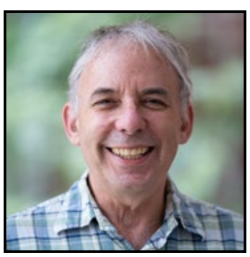
Thad Walker

Professor Thad Walker was honored with a Vilas Distinguished Achievement Professorship, an award supported by the estate of professor, U.S. senator and UW Regent William F. Vilas.

These professorships recognize distinguished scholarship as well as standout efforts in teaching and service. It provides five years of flexible funding provided by the Office of the Provost through the generosity of the Vilas trustees and the school or college whose dean nominated the winner.

Maxim Vavilov

Also funded by the Vilas estate, **Maxim Vavilov was named a Vilas Associate**. The competition recognizes "new and ongoing research of the highest quality and significance" and is open to tenure-track assistant professors and tenured faculty within 20 years of their tenure date.



Mark Saffman

Professor Mark Saffman was awarded a WARF professorship. These professorships come with $100,000 and honor faculty who have made major contributions to the advancement of knowledge, primarily through their research endeavors but also as a result of their teaching and service activities. Award recipients choose the names associated with their professorships. Saffman, the Johannes Rydberg Professor of Physics and director of The Wisconsin Quantum Institute, first began work on atomic physics and initiated a long-term effort to develop quantum computers. He is known for his research as a leader in the ongoing development of atomic quantum computers based on the Rydberg blockade mechanism.

Two department projects, **one from Professor Victor Brar and one from Professors Moritz Münchmeyer and Gary Shiu, have been selected for funding in the second round of Research Forward**, a program to stimulate innovative and groundbreaking research at UW–Madison that is collaborative, multidisciplinary and potentially transformative.

Moritz Münchmeyer

The Research Forward initiative is sponsored by the Office of the Vice Chancellor for Research and Graduate Education and is supported by the Wisconsin Alumni Research Foundation, which provides funding for one or two years.

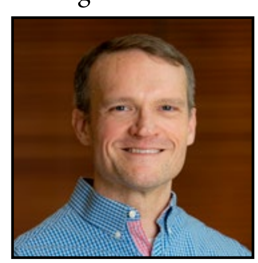
Gary Shiu

Münchmeyer and Shiu's project, "Reconstructing the Big Bang with Physics-Guided Machine Learning," joins physicists and computer scientists together to develop a new technique to look back in time and reconstruct what happened at the Big Bang, aided by recent developments in machine learning.

Brar's proposal, "Multiscale Photonic Structures for Complete Opto-Electronic Control of Light," will lead to creation of a crucial electrical component for holographic displays, high-resolution biomedical imaging, and laser-based range finders valuable for self-driving cars.

Victor Brar

Brar was also named a finalist in the 2022 WARF Innovation Awards for his and scientist Seyoon Kim's invention disclosure that seeks to make telecommunications more affordable. Of the hundreds of new disclosures WARF receives each year, a few are chosen as Innovation Award finalists based on their potential for high long-term impact, presenting an exciting solution to a known important problem, and if they could produce broad benefits for humankind. Two Innovation Award winners, to be named at an upcoming event, will receive $10,000, split among the inventors.



Brian Rebel

Two professors were promoted this year: **Professor Brian Rebel has been promoted to full professor, and Shimon Kolkowitz has been promoted to associate professor** (with tenure).

BOARD OF VISITORS & ALUMNI UPDATES

Greetings from the Board of Visitors

By Tom Holley, BoV Chair, and Jenni Strabley, BoV Vice Chair

Greetings from the Physics Board of Visitors (BoV)! As we continue to emerge from the pandemic, it is encouraging to experience "normal" again. Standing arm-over-shoulder at the L&S All-Board meeting with 300 department representatives and Boards of Visitors members from across the University to sing VARSITY has never felt better.

The fall and spring meetings in 2022 brought the Physics BoV back on campus after several years of virtual meetings. In Spring 2022, the BoV attended the annual department awards banquet. And in Fall 2022, the BoV attended the new Chancellor's luncheon followed by a special session with Dean Wilcots on the state of L&S and a celebration of the 5-year anniversary of the L&S career placement service, SuccessWorks.

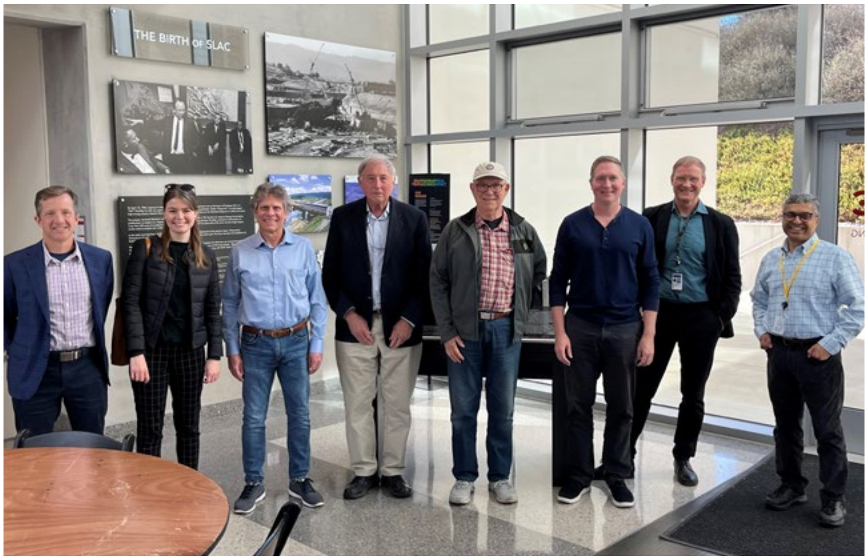
It is reassuring to know that the best is yet to come for the Physics Department.

Being back on campus allows the BoV to assess first-hand how the Physics Department weathered the pandemic. The department is emerging from the pandemic in better shape that when it went in. The numbers of undergraduate physics majors and first year graduate students are on the rise. The first-in-the-nation Master's degree in Physics0 Quantum Computing (MSPQC) has doubled its enrollment. Faculty continue to be awarded prestigious fellowships within the University and professional societies. One-on-one conversation with graduate and undergraduate leaders revealed a resumption of community building, contentment, and appreciation for the department's faculty and staff.

One of the most impressive developments is a rejuvenation of The Wonders of Physics, made possible through hiring the right people and providing the right budget to enable a Physics Department legend to continue its legacy run. This year will be the 40th anniversary of Prof. Clint Sprott's first show, which appears positioned to run another 40 years thanks to the leadership of Haddie McLean. Partial funding for The Wonders of Physics has come from the Day of the Badger fundraising efforts and matching funds.

The BoV has heard from L&S leadership and department leadership about the renewed priority of increasing undergraduate enrollment, both in the number of physics majors but also in the overall number of students taking physics courses. This priority requires thinking differently about how to best serve the students and how to prepare students for careers other than faculty professors. The BoV has a large role to play since many BoV members have careers outside of academia. We believe we can help provide guidance on the skills, experiences, and knowledge base that prepare physics majors for successful careers outside academia. The department will continue its traditional role of preparing students for graduate school, but it will additionally broaden student options to consider other career choices.

The BoV is also committed to financial support for the department. For example, funding has been pledged for the Bernice Durance Faculty Fellowship to help attract world class faculty. We encourage all alumni and friends to join us and plan to donate large or small amounts. We especially want to encourage first time donors to use the Day of the Badger in 2023 to start their personal journeys in giving back to a department that has given us all so much. Please promote your support on your social media channels to make visible the backing of our great university and physics department.



Members of the BOV and Department of Physics toured the SLAC National Accelerator Lab this fall.

It is great to be back in person and on campus, and it is reassuring to know that the best is yet to come for the Physics Department. On, Wisconsin!

Getting to know David Webber

Webber, a former post-doc in the department, joined the BoV in 2022

David Webber

What is your current role?

I am co-founder and chief scientist/technical officer at Scanalytics Inc. where we are making sensor-enabled flooring underlayment to make buildings smarter about their occupancy and energy usage.

Why did you join the BoV, and what is your connection to UW–Madison Physics?

I moved to Madison to study reactor neutrinos. I was in Karsten Heeger's group and worked on the Daya Bay experiment. The international collaboration measured neutrinos produced by reactors near Hong Kong were disappearing; in other words the luminosity of neutrinos far from the reactors was lower than expected from a simple $1/r^2$ drop-off. This disappearance can be explained by electron neutrinos produced in the reactor oscillating into other flavors that the detectors can't see. In technical terms, we measured the neutrino mixing angle θ13 is not zero.

I joined the BoV because the path from physics to industry was not clear to me when I graduated. A physics degree gives a rich training in fundamental science and math that allows physicists to solve complex problems and communicate their reasoning to others. Physics training allows you to do jobs that haven't been invented yet. For example, "Data Science" wasn't a job title when I graduated but now it's both a job title and a major. Physicists are trained to draw conclusions and tell stories from data so I guess you can say that we were doing it before it was cool. People in my network have gone on to be technical managers, directors, and engineers. Rather than going out of date, a physics degree forms the foundation for a lifetime of learning.

What is your favorite physics concept to share with others and why?

I love when people come to me with questions they're curious about, and we can have a conversation about how weird (meaning counter-intuitive) the universe really is! I get questions about astrophysics, relativity, quantum mechanics, the standard model, and the spin of the proton.

People's first exposure to physics in a high-school setting may not communicate how mind-blowing modern physics is, or how we're improving our understanding of the universe all the time. We still don't know what dark matter is made of, or why the standard model is structured the way it is. There's a lot of "white space" where motivated and curious people can make big contributions.

Rather than going out of date, a physics degree forms the foundation for a lifetime of learning.

What else should we know about you?

I'm a gamer, with over a hundred board games in my physical library, and even more in my digital one. My favorite games are ones where the players work collaboratively against a scenario, and we all win or lose together.

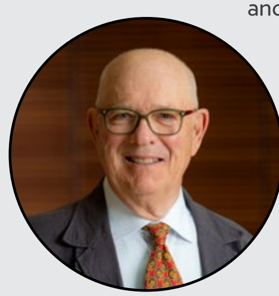
Distinguished Alumni Awards

Given in recognition of successful careers and the limitless possibilities a physics degree offers, these 2020 awards were postponed to 2022 and celebrated at our Awards Banquet in May

Nancy Brickhouse, PhD '84

Nancy Brickhouse earned her PhD in Physics from UW–Madison in 1984. After one postdoc, she joined the Center for Astrophysics | Harvard & Smithsonian, a national lab-like organization of 850+ scientists and staff estimated to have trained 10% of the U.S. astrophysics community. Brickhouse is a Senior Astrophysicist in the Solar, Stellar, and Planetary Sciences Division and previously served as the Senior Science Advisor in the Director's Office. She is a leader in the sub-field of laboratory plasma astrophysics and her research focus is atomic physics of plasmas, spectroscopy, and the physics of stellar coronae with an emphasis on x-ray spectroscopy. She is a co-PI for the proposed Arcus project, a NASA mid-scale explorer mission to study structure and evolution in the universe.

Geoff Fox, PhD '68



Geoff Fox earned his PhD in Physics from UW–Madison in 1968, and his interest in Motocross began while he was a student here. After a postdoc, he joined the physics faculty at Santa Clara University. He and his wife, Josie, were part owners in a motorcycle shop near the SCU campus until Geoff decided to leave teaching to start a business. In 1974, the Fox Racing brand debuted as a mail-order company, and Geoff and Josie were the only employees. By 1985, the Fox brand was focused almost entirely on motocross clothing and it only grew from there. When the Foxes sold the company in 2014, it had expanded to more than 800 employees. The eye-catching Fox logo can still be seen around the world.

Carl Anderson, PhD'79: From UW–Madison to 41 years with IBM Computing

By Sarah Perdue, Department of Physics

When Carl Anderson, PhD '79 returned to campus in 2003 to receive an honorary Doctor of Science, he was a bit distracted with work. His team at IBM, where he worked from the time he graduated until he retired in 2020, was launching a new computer.

"I thought, 'They're giving me an honorary degree, that's a tremendous honor, but I need to get this computer out,'" Anderson recalls. "The day before the ceremony, I was in [now emeritus professor] Jim Lawler's office — he was a very good friend of mine from graduate school — and Wilmer [Anderson, Carl's PhD advisor and no relation] sticks his head in and says, 'Keep your commencement speech short.' I had no idea I was supposed give one!"

In less than 24 hours, Anderson wrote and then gave his short speech — and landed all three jokes he included (the only jokes and laughs in any of the commencement speeches).

Sure, this anecdote is maybe not exactly what Anderson meant when he said his physics education taught him how to solve problems. Still, he credits his time at UW–Madison with providing him the skills he needed to be successful in his career. For example, he used to work physics problem after physics problem over lunch with Ross Spencer in preparation for the qualifying and prelim exams. And he recalls, mostly fondly, working in research labs with limited budgets where he had to teach himself how to build and repair equipment.

Brynn and Carl Anderson in front of their apartment in Madison in the 1970s

He says: "I learned to solve problems, and that's extremely important when you're in industry. You have to solve problems every day and you listen to many, many talks. When the presenters are giving their results, you have to think 'Do I believe them or not? Are their calculations right?' And you need to be able to do it quickly."

Anderson applied to the physics program here based on the advice of his undergraduate advisor at the University of Missouri, who told him that UW–Madison was "a humane school with good physics." He and his wife, Brynn, married in June 1974 and visited Madison for the first time on their honeymoon. They returned in August and stayed for four and half years, and both a daughter and a son were born in Madison.

His first advisor, Dick Dexter, was the one who convinced Anderson that he was an experimentalist, not a theorist. Anderson took that advice to heart, interviewed with several experimental professors, and eventually completed his thesis on high-energy neutral beam generation in Wilmer Anderson's lab. His goal was to get a job at Sandia National Labs in Albuquerque when he left Madison.

"But then IBM made an offer to go work on the first quantum computer, at IBM Research in New York," he says. "So, I changed fields, and we took off for New York."

That first IBM quantum computing program was canceled after four years. Anderson continued his chip design work with GaAs MESFETs, GaAs bipolar transistors, and optical computing. He also became the manager of the GaAs design and fabrication departments.

"Starting in 1991, IBM had challenging financial times, and I actually had to go to work," Anderson says. "The other stuff, before, was just fun."

He became the senior manager of computer chip design in IBM Research. In a joint program with the S/390 division he became the Chief Engineer responsible for transitioning IBM S/390 Mainframe computers from bipolar to CMOS transistors. IBM CEO Lou Gerstner said the CMOS S/390 Mainframe was one of the products that saved IBM. Moving to the IBM Server Division and Austin, TX in 1997 he become Chief Engineer of the IBM gigahertz+ Power Mainframe — the first multicore computer in the industry. In 2000, he became an IBM Fellow, responsible for all aspects of IBM computer chip physical design. In 2007, he moved into IBM Strategy designing a data center in Iceland, developing cloud based servers and data centers in a joint program with Microsoft, building cloud-based applications and consulting with customers. He ended his 41-year career at IBM bringing the IBM Power Architecture into the open source community. Additionally, IBMers are allowed to teach courses at Universities as adjunct Professors. Starting in 2014 until 2018 Anderson jointly taught a cloud computing course at Moscow Institute of Physics and Technology.

In 2012, Anderson became an inaugural member of the Physics Board of Visitors, a committee on which he still serves.

"It's nice to come back and see Madison and see the physics, because with my job, I know the computer stuff but very little modern physics," Anderson says. "It's fun to help the department. I would not have been able to do what I did [with my career] if I did not have the education I received here."

Alumni Updates

Thomas M. Olsen, MS '55 worked 24 years on radioisotope heat source applications as a member of American Nuclear Society. With cessation of all U.S. Government radioisotope contracts in 1980, he applied his learned computer skills at Karsten Ping Golf Manufacturing in Phoenix, AZ, and at Darrell Golf Survey in Los Angeles until retirement in 1995.

Duane H. Jaecks '58, PhD wrote that he is an emeritus professor at the University of Nebraska, Lincoln. He wrote, "I am still writing papers in experimental atomic physics. One of the first seminars at U. Washington that I attended was in Jan. 1961, if memory serves me correctly, by faculty returning from the New York APS meeting and their discussion about talks announcing the construction of a He-Ne laser. Now here we are measuring 1 sec in 300 billion years, when the Universe, as we know it is only 14-15 billion years old. Many years ago, I applied to NSF for funds to buy a laser. The response was, 'What can you learn with that?' I have had the pleasure of interacting with several of your AMO professors, most now have retired. I remember Prof. Haberli in E&M, who was a great teacher. I worked as an undergrad assistant in the shop under the old lecture hall in Sterling, making trim magnets for the original Van de Graaff accelerator. That was only a mere 67 years ago. Time flies when you are having fun."

John Harte, PhD '65 has semi-retired from a faculty position in Ecosystem Sciences at The University of California, Berkeley. He continues to conduct research in both field and theoretical ecology and also mentor students, but has stepped down from teaching. Over the past decades he has contributed to numerous topics in energy and environmental science and policy, and written several textbooks, including "Consider a Spherical Cow: A Course in Environmental Problem Solving."

Philip James, PhD '66 retired as Chair of Physics and Astronomy at the University of Toledo in 2006 and continued as active member of Mars Reconnaissance Orbiter Science Team from 2006 to 2019.

Rick Aster '83, PhD wrote, "So much of what I do today as a geophysicist harkens back to the fundamentals from my undergrad Physics major at UW." He was elected a Fellow of the American Geophysical Union and the American Association for the Advancement of Science in 2021.

Gregg Jaeger '86, PhD has edited a new book, "Quantum Arrangements," on the foundations of quantum theory in honor of his collaborator Michael Horne, who recently passed away. Michael is most known for his work producing the first experimentally testable Bell-type inequality.

Jianping Wang, PhD '91 is now a Senior Research Statistician at Acuity Insurance. He studied with the plasma physics group for his doctorate.

David Cinabro PhD '91 wrote, "After a stint as Department Chair at Wayne State, I have joined the DOE's Office of Science where I have become the Program Manager for Nuclear Physics Facilities. Amusingly, I replace fellow UW alum Jim Sowinski who is retiring in the fall of 2022."

Arnab Bhattacharya, PhD '97 wrote that after 22 years as a professor at the Tata Institute of Fundamental Research (TIFR), where he works on semiconductor optoelectronics, he was offered the directorship of India's national center for science education, the Homi Bhabha Centre for Science Education. He writes, "While I still run my lab at TIFR, doing pretty much what I did for a PhD — epitaxial growth of compound semiconductors — the move to science education is of course a result of my passion to get science out of the lab and into the public domain (inspired by Clint Sprott's Wonders of Physics show and Bassam Shakashiri's explosive chemistry demos)... From science outreach and science popularization somehow things moved towards science education. I take this as one more exciting challenge."

Dana C. Peters, PhD '00 was promoted to full professor at Yale University, in the departments of Radiology and Biomedical Engineering. She is the first woman PhD in Yale Radiology to receive tenure. Her research is in MRI research to develop new tools for imaging the heart, and for imaging cancer, using the new deuterium magnetic resonance imaging, a method pioneered at Yale. She wrote, "My training at UW–Madison, the friendships, the learning and discoveries, the lakes and the terrace, and my amazing mentor (Chuck Mistretta) gave me a lot of strength to do this work, and to 'fearlessly sift and winnow' and to make new discoveries. When I was at Madison, the other two women physics PhD students in my starting class (Vijaya and Samar) were such a source of support also for me. I loved UW–Madison so much, both the happy times and the sad times."

Mark Supanich '01, PhD was elected a Fellow of the American Assoication of Physicists in Medicine this year.

Ali Kheirandish, PhD '17 is now an assistant professor at the University of Nevada, Las Vegas. He studied with Francis Halzen for his doctorate.

James Duff, PhD '18 is now a plasma physicist with the Riverside Research Institute. He studied with John Sarff and the plasma group for his doctorate.

Thanks to everyone who shared an update with us! Do you have an update you would like to see in The Wisconsin Physicist? Please fill out our online form at physics.wisc.edu/alumni-update or email us at news@physics.wisc.edu

2022

Awards and Scholarships

GRADUATE AWARDS

Alann & Arline Paul Award: Ricardo Ximenes

The Allan M. and Arline B. Paul Physics Fellowship is for graduate scholarships in memory of Walter Max Borer, MS '37. Ricardo's research is in theoretical high energy physics. He studies theories beyond the current standard model of particle physics and analyzes their physical predictions observable in current and future experiments.

Karl Guthe Jansky & Alice Knapp Jansky Award: Lekshmi Thulasidharan

This award alternates annually between an outstanding graduate student in the physics and astronomy departments. Karl Guthe Jansky received a BA in physics in 1927 and an MA in physics in 1936, and Alice Knapp Jansky received a BA in sociology in 1929. Graduate student Lekshmi Thulasidharan's interest lies in the field of Galactic dynamics, especially on the studies related to perturbations in the Milky Way disk. Her current research is focused on studying corrugations and density waves in the Galactic disk using the data from Gaia and APOGEE and comparing it against different N-body simulations.

Elizabeth S. Hirschfelder Award: Shu Tian Eu

The Elizabeth S. Hirschfelder award assists women graduate students in physics at UW–Madison. Hirschfelder received a PhD in chemistry in 1930 from UW–Madison. Shu Tian Eu is a graduate student whose research interest lies in model building of high energy particle physics. She is currently working on a vector portal model of dark matter in which the dark sector has a U(1) symmetry. This model can explain why dark matter has such minimal mixing with our observable Standard Model, and has rich phenomenology in the lepton sector.

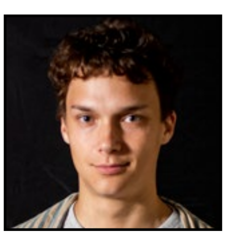
Charles Mendenhall Award: Matt Cambria

The Charles E. Mendenhall Fellowship supports a graduate student in experimental physics. Matt Cambria works with nitrogen vacancy centers (NVs) in diamond, which lie at the intersection of condensed matter, atomic-molecular-and-optical physics, and quantum information. He's specifically studying how the interactions between NVs and vibrations of the surrounding diamond carbon lattice limit the lifetimes of the NV ground-state electronic spin states.

DEPARTMENT TEACHING AWARDS

Joseph R. Dillinger Award for Teaching Excellence:
Scott Lucchini

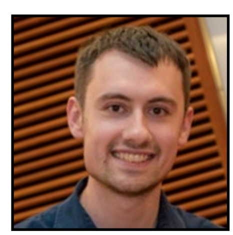
Best TA Spring 2021:
Keenan Smith



Best TA Fall 2021:
Minhal Gardezi

Rookie of the Year:
Justin Marquez

Outstanding Undergraduate Assistant
Jake Murawski



UNDERGRADUATE AWARDS

Dr. Maritza Irene Stapanian Crabtree Award: Mika Xu

The Dr. Maritza Irene Stapanian Crabtree Award was created in honor of the late Maritza Stapanian Crabtree '71, to offer other talented young people a chance to follow their dreams. Mika Xu is an undergraduate conducting research in plasmas, with a future goal of plasma propulsion.

Bernice Durand Research Scholarship: Elyse Incha

The Bernice Durand Undergraduate Research Scholarship is given with preference to women or to ethnic minorities in physics and astronomy who show research potential, motivation and interest in the discipline. Elyse Incha currently works in astronomy, specifically exoplanet research. One of her projects includes detailing single transit systems observed in the final observation set of the Kepler telescope, K2 Campaign 19. The other centers on detailing a small Mars-sized planet observed orbiting a bright, Sun-like star by TESS. She loves researching exoplanets, and is interested in what makes an exoplanet habitable for alien life.

Hagengruber Scholarship: Drake Miller

The Hagengruber Scholarship was established by Roger Hagengruber for a Wisconsin resident undergraduate physics student who shows exceptional promise for a future in physics. Drake Miller is a physics major from Racine, WI who is currently conducting research on the topic of plasma astrophysics in galaxy clusters. His research focuses on simulations that analyze small-scale plasma instabilities, dominant wave frequencies, and resonances within the plasma of the intracluster medium (ICM). The goal of this research is to better understand small-scale mechanisms that contribute to ICM plasma heating and stability.

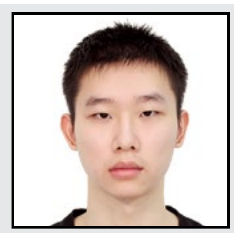
Liebenberg Family Scholarship: Isaac Barnhill

The Liebenberg Family Scholarship is awarded annually based on merit to a junior majoring in physics. Isaac Barnhill is currently working with the Wisconsin Plasma Physics Lab on the Big Red Ball. His research involves modeling the vessel to predict how the internal magnetic fields will react when different configurations of conductors are placed inside. He is interested in how magnetic reconnection events provide energy for coronal mass ejections in stellar atmospheres. He plans to attend graduate school and continue studying stellar astrophysics. His main interest is binary object merger events.

Ingersoll Award, Best Coursework in Physics 247: Ella Chevalier

Ingersoll Prizes are awarded to students who have done the best work in the undergraduate courses. Ella Chevalier received the highest grade in Physics 247. She is interested in working in astrophysics, particularly planetary and space science. She is fascinated by the possibility of extraterrestrial life and is curious about exoplanets that could be habitable. She is also interested in dark matter and dark energy. In the future, she hopes to engage in research that searches for habitable exoplanets and analyzes the possibility that they have life.

Ingersoll Award, Best Coursework in Physics 248: Shunjie Zhu



Ingersoll Prizes are awarded to students who have done the best work in the undergraduate courses. Shunjie Zhu received this honor for Physics 248. In the course, he worked on matter waves.

Ingersoll Award, Best Coursework in Physics 249: Will Cerne

Ingersoll Prizes are awarded to students who have done the best work in the undergraduate courses. Will Cerne received this honor for Physics 249. He will be doing theoretical cosmology research with Professor Moritz Münchmeyer, where he will be observing early models of the Universe and seeing if modern-day observations align with these predicted models.

OTHER STUDENT AWARDS & HONORS

Google Quantum Computing Fellowship: Margaret Fortman

Google created the PhD Fellowship Program to recognize outstanding graduate students doing exceptional and innovative research in areas relevant to computer science and related fields. The fellowship attracts highly competitive applicants from around the world, and Fortman earned one of only four in quantum computing.

L&S Teaching Mentor: Shu Tian Eu

To be named an L&S Teaching Mentor (formerly Teaching Fellow) is an honor granted to TAs from the College of Letters & Science who have achieved outstanding success as students and teachers. Teaching Mentors serve as instructors at the L&S Fall TA Training, which takes place at the start of the fall semester and welcomes ~400 new and experienced TAs from across campus. Shu Tian Eu was one of 15 graduate students accepted as a Teaching Mentor for 2022.

Open Quantum Initiative Fellow: Katie Harrison

Undergraduate physics major Katie Harrison was a member of the inaugural class of Open Quantum Initiative Fellows. Run through the Chicago Quantum Exchange, OQI has a goal of connecting students with leaders in academia and industry and increasing their awareness of quantum career opportunities. Katie and 11 other students were paired with mentors at CQE member institutions, where they conducted research in quantum science information and engineering.

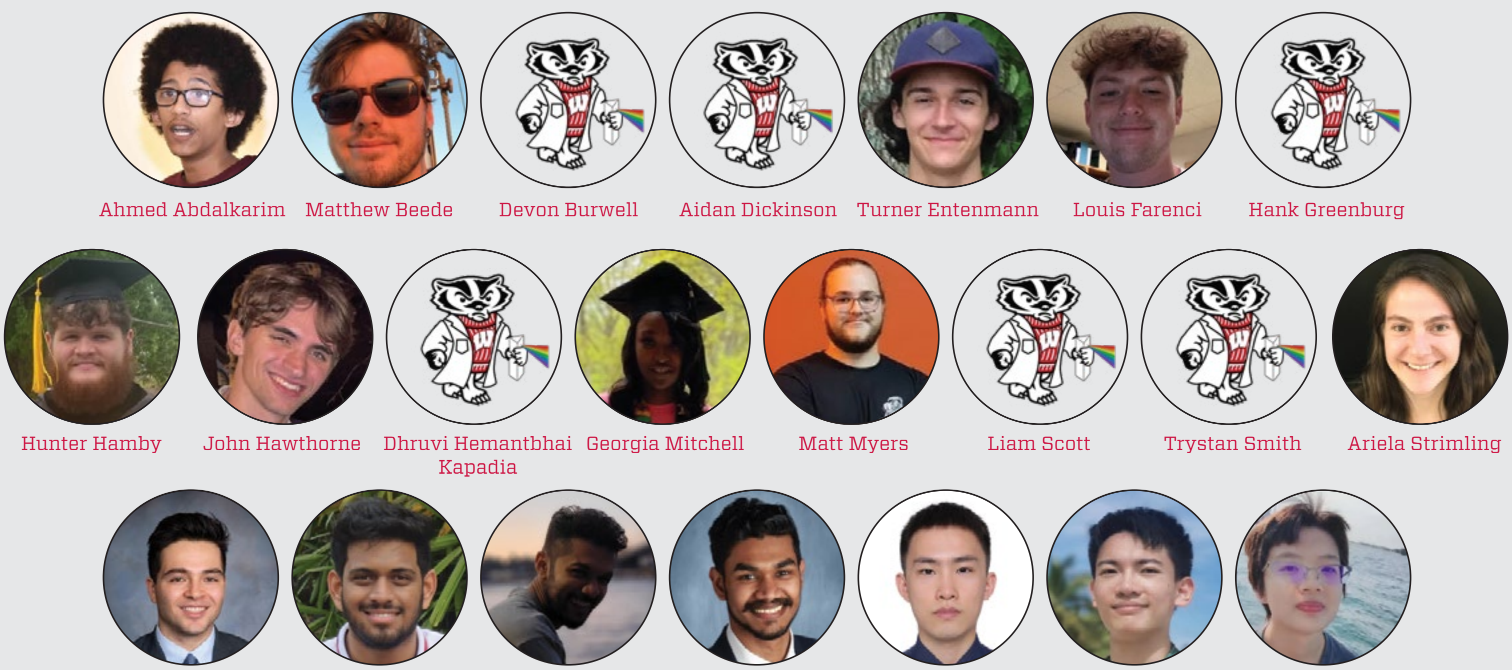
Goldwater Scholarship: Lucy Steffes

Astronomy-physics and physics major Lucy Steffes was one of four UW–Madison students to earn a 2022 Barry Goldwater Scholarship, one of the most prestigious awards in the U.S. for undergraduates studying the sciences. The scholarship program honors the late Sen. Barry Goldwater and was designed to develop highly qualified scientists, engineers and mathematicians.

Hilldale Scholars: Elyse Incha, Haoyi Jia, Daniel Laws, and Nico Ranabhat

The Hilldale Undergraduate/Faculty Research Fellowship provides research training and support to undergraduates at UW–Madison. Students have the opportunity to undertake their own research project in collaboration with UW–Madison faculty or research/instructional academic staff. Jia is conducting research in the Department of Physics, while Incha and Laws are physics majors conducting research in other departments. Additionally, engineering physics major Nico Ranabhat received an award for research being conducted in our department.

Welcome, Incoming MSPQC Class of 2022!



Ahmed Abdalkarim, Matthew Beede, Devon Burwell, Aidan Dickinson, Turner Entenmann, Louis Farenci, Hank Greenburg

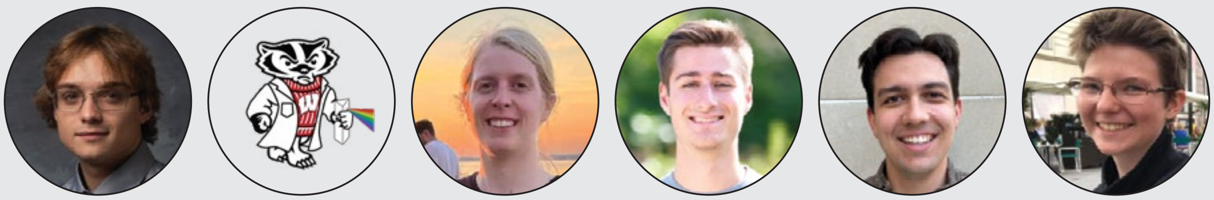
Hunter Hamby, John Hawthorne, Dhruvi Hemantbhai Kapadia, Georgia Mitchell, Matt Myers, Liam Scott, Trystan Smith, Ariela Strimling

Kevin Tactac, Preetham Tikkireddi, Atharva Vidwans, Anosh Ben Asher Wasker, Yongxiao Yan, Bruce Zhou, Yeqing Zhou

Welcome, Incoming PhD Class of 2022!

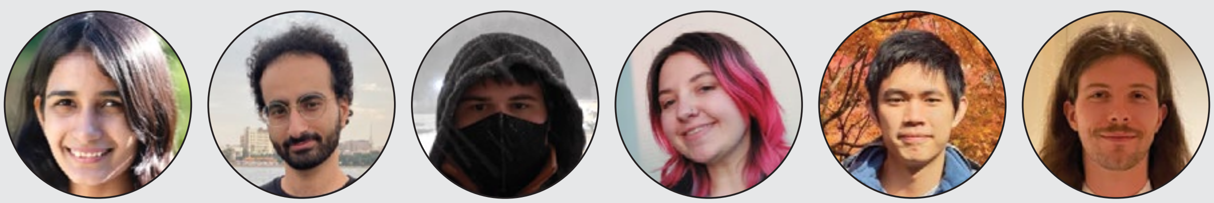
Rafael Alapisco | Ben Antognetti | Arifa | Mason Austin | Julian Beas-Gonzalez | Brooke Becker

Elam Blackwell | Braden Buck | Delaney Butterfield | Dean Chen | Robin Chisholm | Soyeon Choi | Zach Curtis-Ginsberg

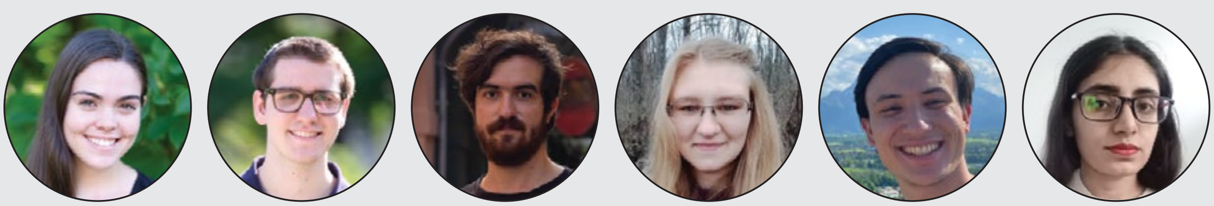


Joshua Doucette | Shreya Dwivedi | Hannah Erpenbeck | Owen Eskandari | Joseph Flahavan | Miranda Gorsuch

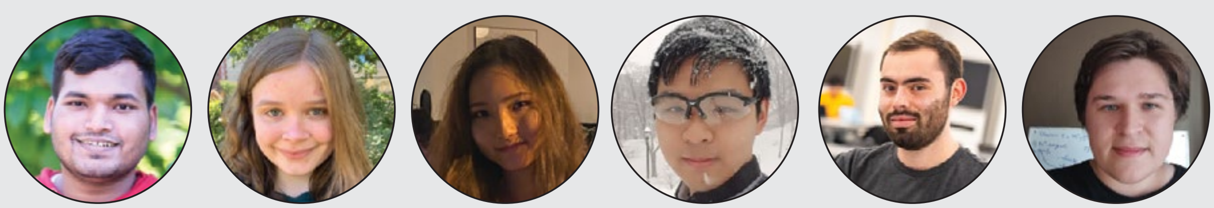
Samuel Hori | Aubrey Houser | Zachary Jerzyk | Sam Kramer | Puxin Lin | Michelle Marrero Garcia | Ansibert Miruko



Aakankshya Mishra | Omar Nagib | Maxwell Nakos | Sophia Nowak | Linipun Phuttitarn | Caleb Robinson



Alysa Rogers | Jarrett Rosenberg | Utku Saglam | Julia Sheffler | Ryan Simeon | Hudaiba Soomro



Mitanshu Thakore | Hannah Woodward | Mary Yu | Mason Yu | Perri Zilberman | Dmitry Zverevich

Physics Degrees Awarded

Undergraduate Degrees

Fall 2021

Scott Lynch
Zijian Pan
Jacob Schellpfeffer

Spring 2022

Michael Bergdolt
Cameron Boulier
Delaney Butterfield
Yuze Chen
Hyunheung Cho
Sam Christianson
Robert Eigenberger
Mitchell Faust
Tyler Fredrick
Maxwell Freeman
Jiaxin Gong
Ziyang Hang
Zachary Honadel
William Huang
Payton LaPorte
Creighton Lewis
Renxi Li
Yanfei Li
Thomas Litecky, Jr
Mingrui Liu
Evie J Mahsem
Mackenzie McCourt
Jake Murawski
Prasoon Rathore
Finn Roberts
Grace Roemer
Gage Siebert
Haley Stueber
Nicholas Thoreson
Jonas Tost
Nikhilesh Venkatasubramanian
Sebastiaan Wakker
Alexander Wilkinson-Johnson
Mika Xu
Thomas Yan
Xinyu Yu
Ao Zhang

Summer 2022

Jonathan Bailey
Lennart Justen
Anthony McCann
Jeremy Peplinski
Joseph Peplinski
Zhengyao Huang

MA/MS Physics Degrees

Michael Campanella
Roark Habegger
Sarah McCarthy

MS Physics – Quantum Computing Degrees

Brooke Becker
Soyoen Choi
Jacob Frederick
Bobby Luo
Evan Ritchie
Utku Saglam
Yen-An Shih
Reid Vorbach
Qianxu Wang
Jin Zhang

Doctoral Degrees

Fall 2021

Joelle Corrigan
Advisor: Eriksson

Raamis Hussain
Advisor: Vandenbroucke

Ping-Yu Li
Advisor: Terry

Leslie Taylor
Advisor: Vandenbroucke

Chris Wilen
Advisor: McDermott

Spring 2022

Gregory Holdman
Advisor: Brar

Robert Morgan
Advisor: Bechtol

Jonathan Nikoleyczik
Advisor: Dasu

Trevor Oxholm
Advisor: Timbie

Alex Pizzuto
Advisor: Vandenbroucke

Chris Young
Advisor: Saffman

Summer 2022

Wyatt Behn
Advisor: Brar

Gage Bonner
Advisor: Thiffeault, Everett

Kayla Leonard DeHolton
Advisor: Halzen

Harsha Gurram
Advisor: Egedal

Harry Hausner
Advisor: Rebel

Evan Heintz
Advisor: Zweibel

Xiaoyu Jiang
Advisor: Saffman

Andrew Loeliger
Advisor: Bose

Gregory Loges
Advisor: Shiu

Anh Phan
Advisor: Timbie, Bechtol

Ibrahim Safa
Advisor: Halzen

Joel Siegel
Advisor: Brar

GIFT GIVING GUIDE

PRIORITY FUND: The Wonders of Physics Outreach Fund

Established in 1984, the mission of the Wonders of Physics is to generate interest in physics among people of all ages and backgrounds. The Wonders of Physics (TWOP) is an entertaining and educational program, demonstrating key elements of physics, including motion, heat, light, sound, electricity, magnetism, and modern physics. In 2023, we'll be hosting our 40th annual series of shows, which has entertained over 100,000 guests. Including the Wonders of Physics Traveling Show, we've reached well over 300,000 people from all across Wisconsin and beyond. We look forward to offering this engaging outreach program for another 40 years!

Please visit go.wisc.edu/support-twop to give online, or mail in the form on page 24

OTHER DEPARTMENT FUNDS

UNDERGRADUATE

Fay Ajzenberg-Selove Scholarship Fund

Dr. Maritza Irene Stapanian Crabtree Undergraduate Scholarship Fund

Bernice Durand Undergraduate Research Scholarship Fund

Henry & Eleanor Firminhac Physics Scholarship Fund

Liebenberg Family Scholarship in Physics Fund

Hagengruber Fund

Physics Board of Visitors Undergraduate Research Fund

GRADUATE

Allan M. and Arline B. Paul Physics Fund

Carl and Brynn Anderson Graduate Physics Fund

Cornelius P. and Cynthia C. Browne Endowed Fellowship Fund

Joseph R. Dillinger Teaching Award

Albert R. Erwin, Jr. — Casey M. Durandet Graduate Student Fund

Elizabeth S. Hirschfelder Endowment for Graduate Women in Physics

Karl Guthe Jansky & Alice Knapp Jansky Fellowship Fund

Van Vleck Fellowship

E. R. Piore Award Fund

Physics Alumni Graduate Award Fund

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Gerald W. and Tui G. Hedstrom Physics Fund for Graduate Support

Roberston Leach Graduate Student Fund

Graduate Student Recruiting Fund

L. Wilmer Anderson & Dave Huber Graduate Support Fund

Robert M. St. John Graduate Support Fund

Jeff and Lily Chen Wisconsin Distinguished Graduate Fellowship

Raymond G. and Anne W. Herb Wisconsin Distinguished Graduate Fellowship

GENERAL

The Newton Fund

Barschall Enterprise Fund

Ray Macdonald Fund for Excellence in Physics

Friends of the L.R. Ingersoll Museum Fund

Willy Haeberli Fund for the L.R. Ingersoll Physics Museum

George E. Ott Award for Staff in the Department of Physics

David Grainger Physics Library Energy Sources College Fund

Physics Community Building Fund

Jane and Clarence Clay Fund for Chaos and Complex Systems

Physics Research Fund for Quantum Science

Raymond G. and Anne W. Herb Endowment Fund in Physics

L.R. Ingersoll Physics Fund

Dalton D. Schnack Memorial Fund

Atomic Collision Research Fund

Elementary Particle Physics Institute Fund

Quantum Computing Research Center Fund

Thomas G. Rosenmeyer Cosmology Fund

John H. Van Vleck Physics Endowment Fund

ENDOWED CHAIRS

Bernice Durand Faculty Fellowship in Physics Fund

Martin L. Perl Chair Fund

Emanuel Piore Professorship Fund

Dunson K. Cheng Chair in Physics Fund

Carl J. and Brynn B. Anderson Professorship in Physics Fund

Please visit https://physics.wisc.edu/giving/funds/ for fund descriptions or to make a secure gift with your credit card. A mail-in donation form may be found on page 24 of this newsletter.

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I wish to designate my Gift to the following fund(s) (please see Page 23 for fund details)

☐ **The Wonders of Physics Outreach Fund (Fund #132698078)**

☐ **Other fund (please write in fund name):** _____________________________________

Should you prefer to make your donation electronically by credit card on a secure server, please go to https://physics.wisc.edu/giving/funds. Click on the fund in which you are interested for more information, and then complete the UW Foundation secure site form.

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Madison, WI 53706-1390

Join us this February for the 40th annual The Wonders of Physics shows!

For more info, visit: wonders.physics.wisc.edu