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Department of Physics
UNIVERSITY OF WISCONSIN–MADISON

The Wisconsin Physicist

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The Wisconsin Physicist is the newsletter for alumni and friends of the:
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Page 1 (left): PRX Quantum
Page 6: Flatiron Institute
Page 9 (bottom right): HRL Laboratories
Page 10 (left): Illustris Collaboration; (right): PRX Quantum
Page 11: IceCube/NSF (Lily Le & Shawn Johnson)/ESO (S. Brunier)

On the Cover

Physics is for everyone, and to convey that message visually, the department commissioned a mural to serve as a bright, welcoming sign to the thousands of students, visitors, and community members entering Chamberlin Hall each year. Proposals were solicited in late 2022, and a committee of department faculty, staff, and students landed on artist Mauricio Ramirez's submission, "Poly-wave: Seeds of Color and Shape." Of the design, Ramirez says, "The piece opens to a world of color, difference and individuality. The separate colors and shapes create the harmony of the integrated whole." Physics elements are incorporated throughout, and observers tend to find something new every time they look. We encourage you to visit our mural the next time you are on campus!

View a time-lapse of the mural's installation at
go.wisc.edu/Physics-Mural

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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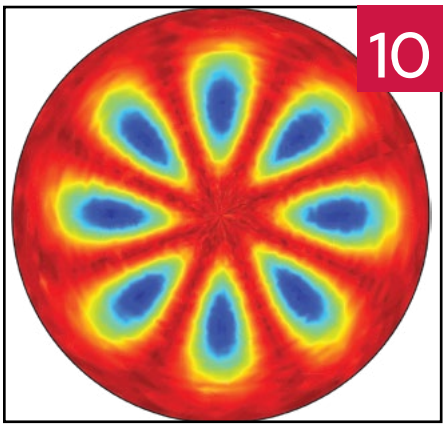


GREETINGS FROM THE CHAIR

Dear Alumni and Friends,

This year, I would like to start by highlighting our students. Our graduate programs continue to admit strong classes of students into both our PhD program and our MS in Physics–Quantum Computing program. This fall, we welcomed 26 PhD and 21 MSPQC students. Our undergraduate programs, both the physics and AMEP majors, are steadily growing as well.

Several students won awards this past year. PhD students Samuel Hori and Alysa Rogers, along with physics major Emil Pellett '23, all received the National Science Foundation's Graduate Research Fellowship, one of the most prestigious awards available to graduate students. This summer, PhD student Jimena González won an Open Science Grid award, the David Swanson Award, for her application of high-throughput computing to the filtering of galaxy images.

PhD students Sam Kramer, Justin Marquez, and Soren Ormseth, who have served the department as Teaching Assistants, won UW–Madison teaching awards. Undergraduate physics major Dhanvi Bharadwaj won a Hilldale Research Fellowship, while Erica Magee and Elias Mettner, both physics majors, earned Sophomore Research Scholarships. Erica, not coincidentally then, also won the department's Ingersoll Award for best overall performance in the introductory honors sequence Physics 247-248-249.

This year, we made an important and exciting change to Physics 247-248-249: all three courses are now available during both fall and spring semester for the first time, which importantly allows more flexibility to students to start the physics major. This very positive impact is already being felt.

We continue to innovate in our efforts to make the classroom experience better for all students who enroll in our department's courses. We have hired Dr. Carrie Francis to help us with continual innovation and improvement in our physics courses serving the university as a whole. We also welcome Rachel Zizmann, who is working to improve the educational and professional experience for students across the full breadth of our department. Dr. Jim Reardon developed a new course, Physics 106: The Physics of Sports, which is growing rapidly and enrolling non-majors as a physical sciences breadth course. In two offerings, it has required a wait list early in the enrollment period. Professors Moritz Münchmeyer and Gary Shiu are introducing a new course for Spring 2024, Physics 361: Machine Learning in Physics, which reflects the growing use of machine learning and artificial intelligence in answering physics questions.

Please join me in congratulating Professor Robert Joynt on his retirement, effective July of this year. Many of you know Bob from at least one of his many contributions to the department. He has served as department chair, was an early pioneer of quantum computing research here, and has long been a champion of physics outreach. Bob also began two initiatives that will have additional long-lasting impacts on our department. It was Bob's vision and effort that led to the creation of the MS in Physics–Quantum Computing program, the first such program in the U.S. and one that has since guided the development of similar programs at other institutions. Bob was also critical in establishing the Physics Board of Visitors (BoV). Bob emphasizes that his retirement is solely from teaching and administrative duties, as he continues his strong research program.

MSPQC leadership is now in the capable hands of two people. Prof. Deniz Yavuz has been named the faculty director of the program, and he is already leading efforts to expand and enhance the program. Dr. Katerina Moloni, who was previously on our BoV and a senior scientist at nPoint, joined the department last December as Associate Director of the MSPQC program. Katerina has an additional role as associate director of the Wisconsin Quantum Institute. In under a year, she has done a fantastic job of organizing and centralizing quantum activities across campus. Quantum outreach in our department will continue to thrive with the hiring of Sarah Parker as quantum outreach program manager in October. She joins us with an extensive background in physics and astronomy outreach and an emphasis on improving accessibility of demos.

We are welcoming three new faculty as assistant professors in January 2024. Rogerio Jorge and Vladimir Zhdankin '11, PhD '15 are plasma theorists who study stellarator design and extreme astrophysical plasmas, respectively. Matt Otten is an AMO and quantum computing theorist whose work focuses on improving quantum algorithms and qubit design.

Sadly, the department said farewell to three faculty. Professor Emeritus Don Cox and Professor Marshall Onellion passed away in late 2022, and Professor Emeritus Jim Lawler passed away in January of this year. They were all vibrant contributors to our department who will be missed greatly. We also lost two long-time staff members. Emeritus department accountant and research program manager Ed Slotten passed away in June. And senior instrumentation technologist Peter Weix, who joined the plasma group in 2001, passed away in January. He was the recipient of the 2022-23 George Ott staff award, which was presented to his wife at our awards banquet in May.

Peter also had served as the emcee for the Wonders of Physics Annual Show for over 200 shows. The Wonders of Physics celebrated its 40th season this February, and we had a ceremonial passing of the baton from its founder and greatest supporter, Prof. Emeritus Clint Sprott, to Haddie McLean. Haddie has been running the in-person and traveling show for two years now and will continue to showcase all we love about physics to audiences across the state. Haddie has made it to around one-third of Wisconsin counties in two years, and she'd love to check them all off in the next two years. Contact her to learn which counties she has left, and to schedule a show if you live in one of them!

Our faculty continue to earn professional honors, both within and outside the university. Prof. Lu Lu received a 2023 International Union of Pure and Applied Physics's prestigious Early Career Scientist Prize. Profs. Victor Brar and Ke Fang both earned National Science Foundation CAREER awards, which are NSF's most prestigious awards in support of early-career faculty. And both Profs. Kyle Cranmer and Tulika Bose were named to the Particle Physics Projects Prioritization Panel (P5). P5 is a panel of ~30 High Energy Physics experts that advises the Department of Energy Office of Science and the National Science Foundation's Division of Physics on high energy and particle physics matters.

At UW–Madison, Prof. Robert McDermott has been named the Robert E. Roeske Professor of Physics. Prof. Justin Vandenbroucke earned a Vilas Associates award, and Prof. Alex Levchenko earned a Romnes Faculty Fellowship. Prof. Brar and Prof. Keith Bechtol were both promoted to Associate Professor of Physics this summer, with tenure. And long-time undergraduate physics major advisor, Prof. Dan McCammon, earned a 2022-23 Distinguished Academic Advising Achievement Award, the highest advising honor the College of Letters & Science bestows.

On, Wisconsin!

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

FACULTY UPDATES

We welcome three new faculty, wish one a happy retirement, and say goodbye to three dear colleagues

Welcome, Professor Rogerio Jorge!

Plasma theorist Rogerio Jorge will join the UW–Madison physics department as an assistant professor on January 1, 2024. He joins us from Instituto Superior Técnico (IST) in Lisbon, Portugal, where he is a research professor. Jorge completed his first postdoc at the University of Maryland at College Park, then accepted a Humboldt Fellowship where he worked on the design of fusion energy devices in Greifswald, Germany.

Please give an overview of your research.

My work is twofold: I uncover basic plasma physics phenomena and apply my plasma physics knowledge to the realization of fusion energy. My most recent work is devoted to the design of Stellarators, a type of fusion machine that is free of major instabilities and disruptions. Here, we try to have this clean renewable energy available to the world as fast as possible. I've been doing research on fusion since my PhD studies, where I focused on one type of device called the Tokamak; when I went to the U.S. for my postdoc, I started focusing on the Stellarator. The Stellarator has had a lot of research since the '60s, but only recently it had a big resurgence.

Thanks to the enormous progress in computational power, I do a lot of simulations for my work. I have worked on several codes, each focusing on a particular physics or engineering problem, such as electromagnetic coils, stability, turbulence, and energy retention, which are all used in combination to do designs for new machines. I also collaborate with startups seeking to rapidly develop fusion energy and supervise students and postdocs who are trying to get new designs for new machines. Most of our work is in the realm of classical physics, based on things that people learn while they're majoring in physics, such as electrodynamics and electromagnetism. But then, we couple it with new computational and mathematical techniques, such as machine learning, to streamline our workflow.

We have ideas for Stellarator design that could allow for much better performance than we had before, so that the resulting devices achieve higher temperatures and higher densities. However, we should always take into account that theory and experiment may operate on different planes. We are in contact with experimentalists who sometimes tell us, "Your machine is too complicated to build!" And then we have to go back and incorporate their constraints into the design.

What are one or two research projects you'll focus on first?

Stellarator design and optimization will be one of the main branches, and we have many projects that either could start or have already started in my research group that we will be continuing in Madison. One of these topics is the confinement of fast particles resulting from fusion reactions — that is, alpha particle dynamics. These must stay confined long enough to continuously feed energy to the plasma, leading to what we call a burning plasma. Right now, the machines we have are still prototypes, meaning that they haven't made many studies on the physics of burning plasmas. We still need to do a lot of research on it. Once we turn on the machine and start getting a lot of energy, we must be able to predict what's going on. Burning plasma physics or fast particle physics is one of the major issues. Besides burning plasma physics, I will also continue the work on Stellarator optimization, with a particular focus on how machine learning can help us obtain increasingly better designs and how to incorporate experimental constraints into the optimization.

Another branch will be the study of basic plasma physics with a particular focus on astrophysical plasmas. During my PhD, I developed a method to accurately incorporate collisions between charged particles in plasmas. I intend to further develop that technique, creating a numerical tool that is easy to use and can be used to predict extreme events in space, as well as predict the behavior of plasmas in the lab, such as the Wisconsin Plasma Physics Laboratory.

What attracted you to Madison?

Madison has one of the best physics departments in the world, particularly in my area of plasma physics. I believe it's one of the top places that people think of when they do the sort of work that I do, Stellarators and basic plasma physics. This is because there is a prototype fusion device here, myriad experimental plasma physics facilities, and people doing state-of-the-art theory and simulation. Furthermore, when I visited Madison, I loved the views, the lakes, and the overall quality of life.

What is your favorite element or elementary particle?

I think I like the neutrino. It was fun learning about neutrinos in particle physics. They were thought to have no mass, but their flavors can actually oscillate while they travel, and this yields a very tiny but finite amount of mass. Besides, they can go through essentially everything without getting detected — they're basically invisible! It's something that you think you know what it is, and you know all the calculations and you understand it, but at the end of the day, experiments and nature tell you that you don't exactly know what you think you know. They seem so simple, yet there is more to the story.

What hobbies and interests do you have?

Definitely music. I play the guitar and I like to learn how to play new instruments. I have a few instruments around the house but the one that I am learning how to play right now is the violin. Like the neutrino, even with only four strings, it's a deceivingly complicated instrument.

Welcome, Professor Matthew Otten!

Atomic, molecular and optical and quantum theorist Matthew Otten will join the UW–Madison physics department as an assistant professor on January 3, 2024. He joins us most recently from HRL Laboratories. Prior to HRL, Otten earned his PhD from Cornell University, and then was the Maria Goeppert Mayer fellow at Argonne National Laboratory.

Please give an overview of your research.

Very generally, my goal is to make utility scale quantum computing a reality, and to get there faster than we would otherwise without my help. We have a lot of theoretical reasons to believe that quantum algorithms will be faster in certain areas; in practice, we need to know how expensive it's going to be. It could be that a back of the envelope calculation says a quantum computer might be better, but because quantum computers are very expensive to build and have a lot of overhead, you could find that once you crunch the numbers really carefully, it turns out to cost more money or more energy or more time than just doing it on a supercomputer. In that case, it's not worth the investment to build it, or at least not at this point. Part of my research is to understand and develop quantum algorithms and count how expensive they are. Once you do that, you can figure out the reason it's so expensive is A and B. Then we go and we try to fix A and B, and then whack-a-mole all these bottlenecks down and eventually you go from, "It'll never work," to "Okay, it'll work in twenty years."

Another part of my research is looking at the physical qubits. These devices all have a lot of deep physics inside of them. If you just look at it from the quantum algorithm level, you might get so far. But if you dig down and try to understand the underlying physics, I think you can get further. You might be able to make devices cheaper, faster, or more performant in general. I do a lot of simulations of the underlying physics of these various types of qubits to understand what their properties are, what causes the noise that ruins computation, and what we can do to fix that noise. Through simulations on classical computers, sometimes very large ones, we come up with ways to tweak the system so that you get better performance, by coming up with better quantum algorithms and better qubits. Put those together and hopefully you get to a better quantum computer.

What are one or two research projects you'll focus on first?

I'll be bringing a few projects with me. The first is part of a DARPA program called Quantum Benchmarking, which I was part of while at HRL. We found really high-value computational tasks, not specifically quantum, that Boeing, which owns HRL, would like calculated: for instance, reducing corrosion. Corrosion causes planes to be grounded for maintenance, which is costly. Reducing corrosion will reduce maintenance costs and increase uptime. We've been developing ways to ask and answer the question, how close are today's quantum computers to solving that problem? How big do quantum computers need to be to solve that problem? The specific task is understanding what it takes to solve such a large-scale problem, counting the quantum resources that are necessary and coming up with tests so that you could go to a quantum computer, run the tests, and hopefully be able to predict how much bigger or how much faster they would need to be to solve the problem.

Another one comes from the Wellcome Leap Foundation. We are trying to do the largest, most accurate calculation of biological objects — a molecule, string of carbon, something like this — possible on a real-life quantum computer. We're trying to take techniques that have already been developed or develop new techniques to make circuits smaller, which means a less expensive quantum computer, and faster. That one is a competition, they gave us funding to do it, but if we complete the task better than other competitors, we get more funding to do more.

What attracted you to UW–Madison?

The strength of the science that's happening in the physics and broader Wisconsin community is very attractive. When I visited, everyone was very nice, it's a very collegial department. And being from St. Louis, I like the Midwest. I've lived in Southern California for a couple of years now and I haven't seen snow, and that's sad. Madison is a lovely area. Great people.

What is your favorite element and/or elementary particle?

I think it has to be silicon. Silicon is used in classical computing and potentially has use in quantum computing. And you're carrying around silicon right now, just like everyone else.

What hobbies and interests do you have?

I have a Siberian Husky puppy and we'll be very happy to go to Madison and do a lot of skijoring, which is cross country skiing, but the dog pulls you. I started running recently and I was jazzed up for my first half marathon — and then I got COVID and I didn't do it, so I'm still jazzed up for my first half marathon. I play a lot of board games and have a very large board game collection. And my daughter just turned one. She's become a new hobby.

Welcome, Professor Vladimir Zhdankin!

Theoretical plasma astrophysicist Vladimir Zhdankin ‘11, PhD ’15, returns to UW–Madison as an assistant professor of physics on January 1, 2024. As a student, Zhdankin worked with Prof. Stas Boldyrev on solar wind turbulence and basic magnetohydrodynamic turbulence, which are relevant for near-Earth types of space plasmas. After graduating, Zhdankin began studying plasma astrophysics of more extreme environments. He first completed a postdoc at CU-Boulder, then a NASA Einstein Fellowship at Princeton University. He joins the department from the Flatiron Institute in New York, where he is currently a Flatiron Research Fellow.

Please give an overview of your research.

These days, most of my interest is in the field of plasma astrophysics — the application of plasma physics to astrophysical problems. Much of the matter in the universe is in a plasma state, such as stars, the matter around black holes, and the interstellar medium in the galaxy. I’m interested in understanding the plasma processes in those types of systems. My focus is particularly on really high energy systems, like plasmas around black holes or neutron stars, which are dense objects where you could get extreme plasmas where relativistic effects are important. The particles are traveling at very close to the speed of light, and there’s natural particle acceleration occurring in these systems. They also radiate intensely, you could see them from halfway across the universe. There’s a need to know the basic plasma physics in these conditions if you want to interpret observations of those systems. A lot of my work involves doing plasma simulations of turbulence in these extreme parameter regimes.

What are one or two research projects you’ll focus on first?

One of them is on making reduced models of plasmas by using non-equilibrium statistical mechanical ideas. Statistical mechanics is one of the core subjects of physics, but it doesn’t really seem to apply to plasmas very often. This is because a lot of plasmas are in this regime that’s called collisionless plasma, where they are knocked out of thermal equilibrium, and then they always exist in a non-thermal state. That’s not what standard statistical mechanics is applicable to. This is one of the problems that I’m studying, whether there is some theoretical framework to study these non-equilibrium plasmas, to understand basic things like: what does it mean for entropy to be produced in these types of plasmas? The important application of this work is to explain how particles are accelerated to really high energies in plasmas. The particle acceleration process is important for explaining cosmic rays which are bombarding the Earth, then also explaining the highest energy radiation which we see from those systems.

Another thing I’m thinking about these days is plasmas near black holes. In the center of the Milky Way, for example, there’s a supermassive black hole called Sagittarius A*, which was recently imaged a year or two ago by the Event Horizon Telescope. It’s a very famous picture. What you see is the shape of the black hole and then all the plasma in the vicinity, which is in the accretion disk. I’m trying to understand the properties of that turbulent plasma and how to model the type of radiation coming out of the system. And then whether we should expect neutrinos to be coming out, because you would need to get very high energy protons in order to produce neutrinos. It’s still an open question of whether or not that happens in these systems.

What attracted you to UW–Madison?

It’s just a perfect match in many ways. It really feels like a place where I’m confident that I could succeed and accomplish my goals, be an effective mentor, and build a successful group. It has all the resources I need, it has the community I need as a plasma physicist to interact with. I think it has a lot to offer to me and likewise, I have a lot to offer to the department. I’m also really looking forward to the farmers’ market and cheese and things like that. You know, just the culture there.

What is your favorite element and/or elementary particle?

I like the muon. It is just a heavy version of the electron, I don’t remember, something like 100 times more massive or so. It’s funny that such particles exist and this is like the simplest example of one of those fundamental particles which we aren’t really familiar with, it’s just...out there. You could imagine situations where you just replace an electron with a muon and then you get slightly different physics out of it.

What hobbies and interests do you have?

They change all the time. But some things I’ve always done: I like running, skiing, bouldering indoors, disk golf, racquet sports, and hiking. (*Cross country or downhill skiing?)* It’s honestly hard to choose which one I prefer more. In Wisconsin, definitely cross country. If I’m in real mountains, the Alps or the Rockies, then downhill is just an amazing experience.

Congrats to Professor Joynt on his retirement!

By Sarah Perdue

37 years after joining the faculty of the UW–Madison department of physics, Prof. Bob Joynt retired this year.

Joynt is a condensed matter theorist who began as an assistant professor in 1986. His early work focused largely on superconductivity, including high temperature superconductors. He also played an important role in better understanding the Quantum Hall effect, dating back to his graduate work and continuing here.

After a decade and a half, his career took a fortuitous turn when he wrote a quantum computing grant proposal with physics professor Mark Eriksson and other researchers in engineering. His work for the past 20 years has mainly focused on understanding the origins of noise and decoherence in quantum systems and in the design of semiconductor structures for quantum computing.

Joynt is a fellow of the American Physical Society and a UW–Madison Romnes Faculty Fellow. He served as department chair from 2011-2014, during which he focused his efforts on department fundraising. He was responsible for starting the Board of Visitors (BoV), a group of people, mostly in industry, with strong ties to the department. The BoV advises and assists on department priorities, plays a leading role in fundraising, and provides a professional network for current students and alumni.

Around 2016, Joynt noted that doctoral students with quantum computing research experience were in such high demand that employers were often entering bidding wars for them. He asked: Was there a way to meet the demands of the quantum computing workforce by training students in a year or two?

And so, thanks to Joynt’s vision and persistence, the MS in Physics–Quantum Computing program — the first MS in quantum computing in the U.S. — enrolled its first cohort in Fall 2019.

Joynt emphasizes that he is only retiring from administrative and teaching duties. He plans to continue his research efforts, sometimes in Madison and often abroad.

Remembering Professor Don Cox

By Prof. Dan McCammon and Department archives

Professor Emerit Donald P. Cox passed away October 26, 2022. He was 79. A plasma astrophysicist, Cox contributed many years to research in his scientific field, to students with whom he worked, and to the department’s teaching mission.

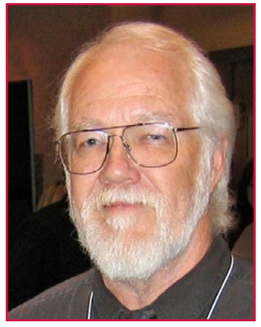
Cox joined the physics department in 1969 with the promise of a faculty position a year before receiving his PhD from the University of California, San Diego. Aside from an extended leave of absence at Rice University while his wife completed her degree in Houston, Cox spent his entire professional career here.

He arrived in the era of a cold and quiet interstellar medium and a newly discovered and unexplained soft X-ray background. For the next four years, he and his students did much of the original work on X-ray plasma emissions from supernova remnants, combining a broad physical insight into global processes with laborious and careful compilations of the necessary atomic physics. At this time, astronomers were still searching for the source of the X-ray background, having apparently eliminated all viable production mechanisms.

Cox looked beyond his remnants and realized that the uniform cold medium that he had been producing them in was incompatible with their collective effects on it. He proceeded to turn astronomy’s conventional picture on its head, proposing the hot, violent, and dynamic picture of the interstellar medium that is taught as a matter of fact today. His subsequent work was marked by a lack of respect for convention and a desire to apply basic physics principles to the complexities of interstellar dynamics. His insight that star formation must have a negative feedback effect on future star formation is today a central tenet of research on galactic evolution.

In following his own path, Cox developed an international reputation as the most original thinker in his field. His legacy of fundamentally new ideas is supplemented by two generations of his students who continue his work.

The other side of Cox’s career was his dedication to teaching, attested to by his



many years as leader of the department’s undergraduate program, his election as a fellow of the Teaching Academy, and numerous unsolicited testimonials from students. He had a desire to share his own joy and fascination with the ideas of physics. He spent hours with pencil and paper, solving a problem that had nothing to do with his research, just to show that some seemingly complex behavior can be derived from basic principles. He did this out of personal curiosity, but his willingness to share his enjoyment of the result was well known.

Remembering Professor Jim Lawler

By Sarah Perdue

Professor Jim Lawler, the Arthur and Aurelia Schawlow Professor Emerit of Physics at UW–Madison, passed away January 29, 2023. He was 71.

Lawler was an atomic, molecular, and optical physicist with a focus on developing and applying laser spectroscopic techniques for determining accurate absolute atomic transition probabilities. He received his MS ('74) and PhD ('78) from this department, studying with now-professor emerit Wilmer Anderson. In the two years after earning his doctorate, he was a research associate at Stanford University, then returned to UW–Madison as an assistant professor in 1980. He remained on the faculty until his retirement in May 2022.

Lawler served as department chair from 1994-97. He also accumulated numerous awards and honors over his distinguished career. He was a fellow of the American Physical Society, the Optical Society of America, and the U.K. Institute of Physics. 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 the Laboratory Astrophysics Prize of the American Astronomical Society for research in spectroscopy.

During his tenure, 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.

Remembering Professor Marshall Onellion

By Prof. Thad Walker, Robert Sundling, and Sarah Perdue

UW–Madison physics professor Marshall Onellion passed away November 20, 2022. He was 72.

After completing his BS in mathematics and physics at West Virginia University in 1972, Onellion served in the U.S. Air Force until he was honorably discharged with the rank of Captain in 1979. He then began graduate studies in physics at Rice University, earning his PhD in 1984 before completing postdoctoral research at the University of Texas, Austin and Harvard University. Onellion joined the UW–Madison physics faculty as an assistant professor in 1987.

A condensed matter experimentalist, Onellion established a vigorous research program that primarily utilized the Aladdin ring at the UW–Madison Synchrotron Radiation Center (SRC) located in Stoughton, WI, for innovative studies of correlated electron materials of various types, including high-temperature superconductors, thin films, and magnetic multi-layers. His workhorse experimental tool was angle-resolved photoemission that was ideally suited to the stable and bright UV SRC synchrotron source.

Over the course of the next 15 years, his work was prolific. He published over 180 peer-reviewed articles, was a thesis advisor to many graduate and undergraduate students, and trained several postdoctoral researchers.

Onellion garnered numerous awards over his career, including being named a Hertz Fellow in graduate school and earning a National Science Foundation Presidential Young Investigator award in 1987. In 1996, he was named a UW–Madison Vilas Research Associate.

For many years Marshall actively volunteered to work with science students in area high schools, primarily Stoughton High School. In recognition of this outstanding service, Marshall received a State of Wisconsin Certificate of Commendation for Public Service from Governor Tommy Thompson in 2000.

Read tributes from colleagues and friends of Prof. Cox, Lawler, and Onellion at go.wisc.edu/9w0s7n. To contribute your own, please email news@physics.wisc.edu

Focus On:

INDUSTRY PARTNERSHIPS

By Will Cushman, University Communications, and Sarah Perdue, Department of Physics

Fueling Fusion

Realta Fusion, a startup with University of Wisconsin–Madison Physics roots, was one of eight companies selected by the U.S. Department of Energy for a grant to support research and development of fusion energy technologies. Earth-based fusion energy, which seeks to mimic the nuclear fusion that powers the stars, could someday provide a source of clean, safe, and virtually limitless power and heat.

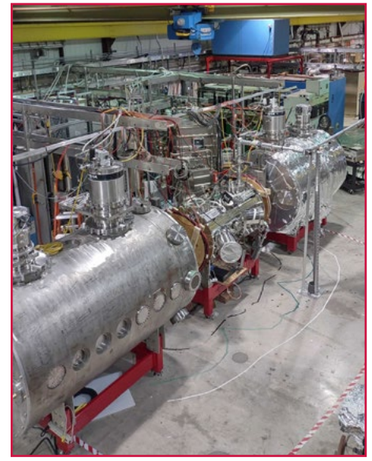
Realta, based in the Madison area, is working to develop fusion energy and heat for industrial applications via a compact but powerful magnetic mirror as an early step toward larger-scale fusion applications. The company was spun out of a federally funded research project housed in the Department of Physics and led by physics professor Cary Forest, who co-founded it and serves as chief scientific officer.

A second company, Type One Fusion, also in Madison and spun out of technology from the electrical and computer engineering department, received DOE funding. This total means that one-quarter of the companies chosen for DOE funding are based in Wisconsin, reflecting UW–Madison's leading role in fusion research to generate renewable and reliable energy as the United States strives to reduce its reliance on fossil fuels.

> ***"We have the key ingredients to make Wisconsin the global hub for fusion."***
> *–Prof. Cary Forest*

Both companies are pursuing potentially simpler and more cost-effective paths to commercializing fusion energy. As they get closer to that goal, UW–Madison's decades-long leadership in the field places Wisconsin at the leading edge of a potential new energy sector.

"UW–Madison has a reputation as one of the leading places in the world for plasma physics and fusion research, and local companies are emerging from that knowledge base," says Forest. "Match that to the deep expertise in manufacturing in the state and we have the key ingredients to make Wisconsin the global hub for fusion."



Realta Fusion is developing fusion technology that uses a magnetic mirror to control plasma. Its design is based on the WHAM experimental device developed at UW–Madison, pictured here.

Collaborating on Quantum Computing

Two leading companies in semiconductor quantum computing are partnering with researchers at the University of Wisconsin–Madison, itself a long-time academic leader in quantum computing.

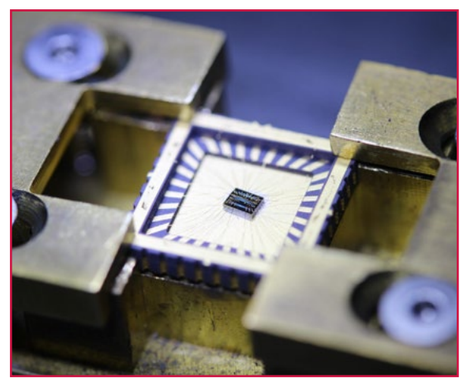
UW–Madison's separate partnerships with Intel and HRL Laboratories are part of a first round of collaborations announced this summer by the LPS Qubit Collaboratory (LQC), a national Quantum Information Science Research Center hosted at the Laboratory for Physical Sciences (LPS). Established in support of the National Quantum Initiative Act, LQC is facilitating partnerships between industry and academic and national labs to advance research in quantum information science.

"One of the motivations for silicon-based qubits has always been that they are electronic devices that can be fabricated using technology very similar to what's used to make integrated circuits," says physics professor Mark Eriksson, the UW–Madison lead on the partnerships. "Companies like Intel and HRL are experts in such technology, and they bring massive expertise and infrastructure into the game."

With the collaborations, Intel and HRL Laboratories will send state-of-the-art chips to Eriksson's group, which will perform experiments to develop improved quantum operations. The research conducted with the chips will inform the companies about their devices and ways to improve them, while UW–Madison students will conduct hands-on research in partnership with industry, advancing research in the field and gaining real-world experience.

> ***"These collaborations give our students a chance to interact with industry partners, which is incredibly important."***
> *–Prof. Mark Eriksson*

"These collaborations give our students a chance to interact with industry partners, which is incredibly important," Eriksson says. "As quantum computing becomes a reality, a lot of these students will go work with industry, some to develop, and increasingly to use, quantum computers."



HRL's semiconductor quantum chip, known as SLEDGE, is one of the quantum computing devices that will be available for UW–Madison researchers.

RESEARCH HIGHLIGHTS

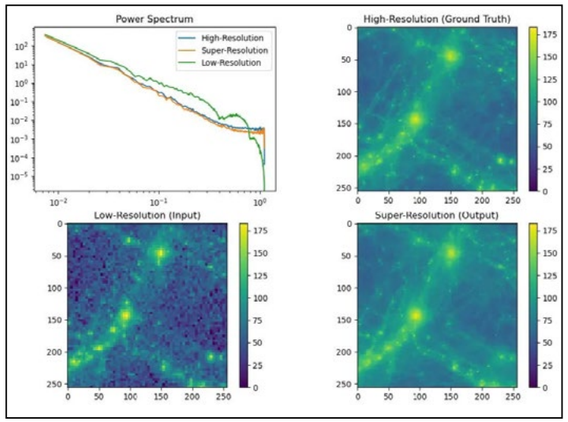
A look back at research from across the department in 2023

Through machine learning maps, cosmic history comes into focus

By Jason Daley, College of Engineering

For millennia, humans have used optical telescopes, radio telescopes and space telescopes to get a better view of the heavens.

Today, however, one of the most powerful tools for understanding the cosmos is the computer chip: Cosmologists rely on processing power to analyze astronomical data and create detailed simulations of cosmic evolution, galaxy formation and other far-out phenomena. These powerful simulations are starting to answer fundamental questions of how the universe began, what it is made of and where it's likely headed.



Using machine learning techniques, Moritz Münchmeyer, Gary Shiu and colleagues are able to produce high-resolution images from low-resolution simulations. These types of techniques could help improve large scale models, like the Illustris Simulation, shown here. In this simulation, dark matter density is overlaid with the gas velocity field.

But simulations are expensive, and time consuming. So three UW–Madison machine learning experts — physics professors Moritz Münchmeyer and Gary Shiu and electrical and computer engineering professor Kangwook Lee, are using emerging artificial intelligence techniques to speed up the process and get a clearer view of the cosmos.

Münchmeyer began by running large-scale, low-resolution simulations, then attempted to upgrade them using a machine-learning technique called normalizing flow. The results, however, weren't as promising as he'd hoped.

That's why he reached out to Lee, who specializes in a type of machine learning called diffusion — a model capable of generating data similar to a data set on which it is trained. In the last year, this type of artificial intelligence has gained wide popularity for generating text-to-image artwork through applications like Stable Diffusion.

With diffusion, the team first focused on dark matter, an unknown type of matter that could account for about 85% of all matter in the universe. The researchers trained the diffusion model on dark matter simulations of various resolutions. By applying the model to low-resolution datasets of dark matter distributions, the team could quickly upgrade the data into high-resolution images. The researchers also applied the technique to gas distribution models derived from the dark matter distributions.

Working across one small patch of sky at a time, then using an algorithm to stitch the data together, they made high-resolution images of the cosmic web of galaxies and galaxy clusters that forms the universe. The implementation of the project was led by physics grad student Adam Rouhiainen and computer science student Michael Gira, with help from Münchmeyer's postdoctoral researcher Utkarsh Giri, Shiu's grad student Jacky Yip, and Lee's students Joseph Shenouda, Ying Fan and Yicong Chen.

And those machine-learning-enhanced images were accurate: The researchers' images proved extremely similar to those produced by running full, high-resolution simulations of the dark matter and gas distributions.

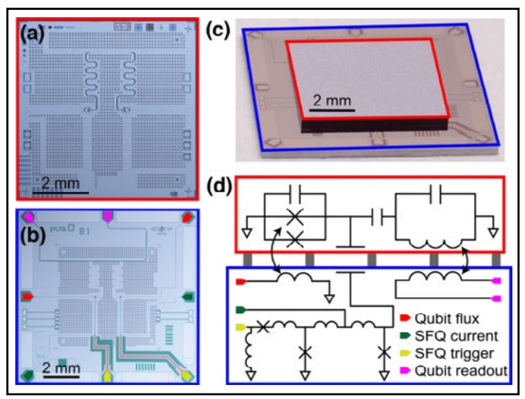
Now the researchers are working on a similar technique that will allow them to apply the same diffusion model to high-resolution cubes of data that they will stitch together to produce 3D maps of the cosmos.

"Sandwich" structure found to reduce errors caused by quasiparticles in superconducting qubits

By Sarah Perdue, Department of Physics

Qubits are notoriously more prone to error than their classical counterparts. While superconducting quantum computers currently use on the order of 100 to 1000 qubits, an estimated one million qubits will be needed to track and correct errors in a quantum computer designed for real-world applications. At present, it is not known how to scale superconducting qubit circuits to this size.

In a study published in PRX Quantum, UW–Madison physicists from Robert McDermott's group developed and tested a new superconducting qubit architecture that is potentially more scalable than the current state of the art. Control of the qubits is achieved via "Single Flux Quantum" (SFQ) pulses that can be generated close to the qubit chip. They found that SFQ-based control fidelity improved tenfold over their previous versions, providing a promising platform for scaling up the number of qubits in a quantum array.



The quantum-classical multichip module (MCM). (a) A micrograph of the qubit chip. (b) A micrograph of the SFQ driver chip. (c) A photograph showing the assembled MCM stack; the qubit chip is outlined in red and the SFQ chip is outlined in blue. (d) The circuit diagram for one qubit-SFQ pair.

The architecture involves a sandwich of two chips: one chip houses the qubits, while the other contains the SFQ control unit. The new approach suppresses the generation of quasiparticles, which are disruptions in the superconducting ground state that degrade qubit performance.

"This structure physically separates the two units, and quasiparticles on the SFQ chip cannot diffuse to the quantum chip and generate errors," explains Chuan-Hong Liu, PhD '23, a former UW–Madison physics graduate student and lead author of the study. "This design is totally new, and it greatly improves our gate fidelities."

Liu and his colleagues assessed the fidelity of SFQ-based gates through randomized benchmarking. In this approach, the team established operating parameters to maximize the overall fidelity of complex control sequences. For instance, for a qubit that begins in the ground state, they performed long sequences incorporating many gates that should be equivalent to an identity operation; in the end, they measured the fraction of the population remaining in the ground state. A higher measured ground state population indicated higher gate fidelity.

Inevitably, there are residual errors, but the reduced quasiparticle poisoning was expected to lower the error rate and improve gate fidelities — and it did.

"Most of the gates had 99% fidelity," Liu says. "That's one order of magnitude reduction in infidelity compared to the last generation."

Importantly, they showed the stability of the SFQ-based gates over the course of a six-hour experimental run.

Later in the study, the researchers investigated the source of the remaining errors. They found that the SFQ unit was emitting photons with sufficient energy to create quasiparticles on the qubit chip. With the unique source of the error identified, Liu and his colleagues plan to develop ways to improve the design.

IceCube shows Milky Way galaxy is a neutrino desert

By Alisa King-Klemperer, WIPAC

The Milky Way galaxy is an awe-inspiring feature of the night sky, dominating all wavelengths of light and viewable with the naked eye as a hazy band of stars stretching from horizon to horizon. Now, for the first time, the IceCube Neutrino Observatory has produced an image of the Milky Way using neutrinos — tiny, ghostlike astronomical messengers.

Published this summer in the journal Science, the IceCube Collaboration — an international group of more than 350 scientists — presented this new evidence of high-energy neutrino emission from the Milky Way. The findings indicate that the Milky Way produces far fewer neutrinos than the average distant galaxies.

What's intriguing is that, unlike the case for light of any wavelength, in neutrinos, the universe outshines the nearby sources in our own galaxy," says Francis Halzen, a professor of physics at the University of Wisconsin–Madison and principal investigator at IceCube.

An artist's composition of the Milky Way seen through a neutrino lens (blue).

The IceCube search focused on the southern sky, where the bulk of neutrino emission from the galactic plane is expected near the center of the galaxy. However, until now, a background of neutrinos and other particles produced by cosmic-ray interactions with the Earth's atmosphere made it difficult to parse out neutrinos originating from galactic sources — a significant challenge compounded by relatively sparse neutrino production in general.

To overcome these challenges, IceCube collaborators at Drexel University developed analyses that select for detections of astrophysical neutrinos from the southern sky. Machine learning methods, developed by IceCube collaborators at TU Dortmund University, further improved the identification of astrophysical neutrinos, along with their direction and energy reconstruction. The observation of neutrinos from the Milky Way is a hallmark of the emerging critical value that machine learning provides in data analysis and event reconstruction in IceCube.

The dataset used in the study included 60,000 neutrinos spanning 10 years of IceCube data. These neutrinos were compared to previously published prediction maps of locations in the sky where the galaxy was expected to shine in neutrinos.

The observation of the galactic plane with IceCube has profound implications. An analysis by Halzen and UW–Madison IceCube colleagues Ke Fang and Jay Gallagher indicates that the Milky Way is 10 to 100 times dimmer in neutrinos than the average of distant galaxies. This may be an important clue to solve the ongoing mystery of precisely where and how these extremely high-energy cosmic rays are produced.

"One implication is that our galaxy has not hosted the type of sources that produced the bulk of high-energy neutrinos for the past few million years," says Fang, "which is roughly the time since the last jet activity of the black hole of our own galaxy."

Planned and future follow-up analyses by IceCube will further understanding of the particle accelerators of the Milky Way galaxy.

FACULTY AWARDS & HONORS

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

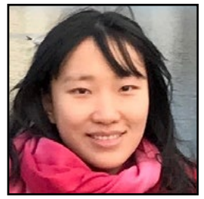
Professional Society and Other External Awards & Honors

Professors Victor Brar and Ke Fang both earned National Science Foundation CAREER awards. CAREER awards are NSF's most prestigious awards in support of early-career faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization.

Victor Brar

Brar will study the flow of electrons in 2D materials, or materials that are only around one atom thick. His group has already shown that when they applied a relatively old technique — scanning tunneling potentiometry, or STP — to 2D materials such as graphene, they could create unexpectedly high-contrast images, where they could track the movement of individual electrons when an electric current was applied. They previously found that electrons flow like a viscous fluid, a property that had been predicted but not observed directly. **Brar also received tenure and promotion this year, and is now an Associate Professor of Physics at UW–Madison.**

Fang's CAREER award is sponsored by the NSF Windows on the Universe: Multimessenger Astrophysics program. In multimessenger astrophysics, scientists search for multiple high energy signals to identify their sources and learn more about the make-up of our universe. WIPAC hosts both the IceCube neutrino telescope and the HAWC gamma ray telescope. Fang will use high-quality data from both telescopes in two ways. First, she will use evolving novel data analysis techniques to study outstanding questions, such as identifying the source of high-energy neutrinos. Then, she will use numerical simulations on those data analysis results. **Fang was also named spokesperson for the HAWC Collaboration.**



Ke Fang

Lu Lu

Professor Lu Lu received a 2023 International Union of Pure and Applied Physics (IUPAP) Early Career Scientist Prize "for her contributions to the development of high energy neutrino astronomy in the PeV energy region."

Early Career Scientist Prizes are given to early-career scientists within each IUPAP commission who have up to eight years of postdoctoral research experience and have made significant contributions to the cosmic ray field. Lu is a recipient of the Early Career Scientist Prize in the Commission on Astroparticle Physics (C4).

Her current research focuses on diffuse high-energy astrophysical/cosmogenic neutrinos from TeV to EeV, Galactic PeVatron detection in the context of multimessenger observations, and the exploration of potential transient ultra-high-energy sources.

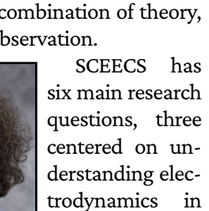
Fang and UW–Madison astronomy and physics professor Ellen Zweibel are part of a new research collaboration announced by the Simons Foundation. The Simons Collaboration on Extreme Electrodynamics of Compact Sources (SCEECS) will study how electrodynamics — the interaction of electric currents and magnetic fields — behave in extreme environments in the distant universe using a combination of theory, simulation, and observation.

Ellen Zweibel

SCEECS has six main research questions, three centered on understanding electrodynamics in neutron stars and three centered on black holes. Each question pairs at least one senior-level investigator with an early-career co-investigator. Zweibel serves as the lead investigator on her black hole question, and she is paired with Richard Anantua at UT-San Antonio. Fang is co-investigator on a neutron star question, and she is paired with Anatoly Spitkovsky at Princeton.

Professors Tulika Bose and Kyle Cranmer were selected for the Particle Physics Projects Prioritization Panel (P5). P5 is a panel of ~30 High Energy Physics experts that advises the Department of Energy Office of Science and the National Science Foundation's Division of Physics on high energy and particle physics matters. The panel will build on the "Snowmass" community study to hash out priorities for the next 10 years within a 20-year context.

Tulika Bose



Kyle Cranmer

Professor Uwe Bergmann is part of a six-year, $18 million grant awarded to the UW–Madison's Materials Research Science and Engineering Center (MRSEC) by the National Science Foundation. The award creates a National User Facility for X-FAST (XUV Femtosecond Absorption Spectroscopy Tabletop), a powerful XUV laser developed by Bergmann's group and housed in the department. He is a co-lead on one of two interdisciplinary research groups, along with materials science and engineering professor and physics affiliate faculty member Jason Kawasaki, that conducts research on magnetics in strained membranes.

Uwe Bergmann

UW–Madison Awards & Honors

Professor Alex Levchenko is one of eighteen UW–Madison faculty to have been honored with H.I. Romnes Fellowships, which recognize faculty with exceptional research contributions within their first six years from promotion to a tenured position. The award is named in recognition of the late WARF trustees president H.I. Romnes and comes with $60,000 that may be spent over five years.

Alex Levchenko

Levchenko studies fundamental aspects of condensed matter physics with a focus on electronic phases of matter and quantum transport. Specific areas of expertise include superconductivity, topological order, and nanoscale systems such as graphene and other van der Waals materials. He is a Fellow of the American Physical Society and of the Alexander von Humboldt Foundation, and recipient of early-career grants from the National Science Foundation and the Binational Science Foundation. His teaching covers all levels of undergraduate and graduate education, and he serves on multiple professional review panels internationally.

Levchenko also earned an L&S Distinguished Honors Faculty award. Each year, the L&S Honors Program solicits student nominations of faculty members or instructional academic staff who have had a special impact as instructors of Honors courses, as supervisors of Honors theses, or as teachers and mentors of Honors students. The Faculty Honors Committee reviews these nominations and votes to confer Distinguished Honors Faculty status on the strongest nominees for these awards each spring.

Professor Justin Vandenbroucke was selected as one of 23 awardees of the Vilas Associates Competition held by the Office of the Vice Chancellor for Research and Graduate Education (OVCRGE).

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. The award will be used to support research in multimessenger astrophysics using IceCube and the IceCube Upgrade, now underway, in combination with gravitational wave and gamma-ray observations to discover and study cosmic particle accelerators.

Justin Vandenbroucke

Victor Brar and affiliate faculty Mikhail Kats received funding in the OVCRGE's Research Forward competition. The Wisconsin Center for Semiconductor Thermal Photonics will explore fundamental science at the intersection of semiconductor technology and radiative heat transfer. This cross-disciplinary center will explore thermal radiation in unconventional semiconductor materials, in nanostructures, and in extreme conditions, and achieve control of the directionality and timing of radiative heat transfer at unprecedented scales. Research Forward is intended to stimulate and support highly innovative and groundbreaking research at UW–Madison.

Professor Dan McCammon has been awarded a 2022-23 Distinguished Academic Advising Achievement Award, the highest advising honor the College bestows.

Dan McCammon

McCammon has served as a research advisor for over 220 undergraduate students, to both physics and non-physics majors, in addition to his academic advising role. He served as the faculty mentor to the Undergraduate Physics Club for three decades, worked with the L&S Honors program to increase the honors section offerings in physics courses, and worked closely with the undergraduate course committees to ensure that physics course requirements are appropriate for all students regardless of their graduate school plans.

Keith Bechtol

Keith Bechtol is an Associate Professor of Physics, after he received tenure and promotion this year. Bechtol is an observational cosmologist with research interests in dark matter and dark energy, using the whole Universe as a lab to understand the fundamental physics of nature.

Robert McDermott

Professor Robert McDermott has been named the Robert E. Roeske Professor of Physics. McDermott is a condensed matter experimentalist with research efforts in the areas of superconducting quantum coherence, quantum measurement, and high-fidelity coherent control.

BOARD OF VISITORS AND ALUMNI UPDATES

Visiting Visitors

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

The Fall 2023 meeting of the Physics Board of Visitors (BoV) was held on 12-13 October. For readers not familiar with the BoV, it is an independent collection of alumni or friends of the Department who meet bi-annually and advise on matters of importance to the Department. In particular we continue to emphasize further enhancement of the prestige of the Department. The perceived prestige is a key factor in recruiting exceptional faculty, postdocs, graduate students, undergraduates, and staff. Our fall agenda topics were all directed toward that end.

UW–Madison Physics and Astronomy Boards of Visitors members and Physical Sciences Laboratory staff in front of the Wisconsin HTS Axisymmetric Mirror (WHAM) at PSL.

One common feature of the most highly regarded physics departments is a large faculty, since the products of faculty, such as innovative research, awards, PhD graduates, and mentored undergraduates, all contribute to Department prestige. Dean Wilcots visited with us and continued to challenge us to identify ways to grow the undergraduate physics program, the growth of which in turn justifies growing the faculty. Dean Wilcots has been and continues to be very supportive in obtaining critical resources including recent faculty hiring, faculty financial support to start up their laboratories, and progress toward more lab space. Thank you, Dean Wilcots.

On the advice of the Board, the Department is discussing how to best enhance the flexibility of the Physics B.S. degree to include the skills, experiences, and knowledge that prepare physics majors for successful careers outside academia after the BS degree. The department will continue its traditional and highly successful role of preparing students for graduate school, but in addition it will broaden student options to consider other career choices. Note that the Applied Math, Engineering, and Physics program (AMEP), in which the Physics Department is a key member, also plays a pivotal role in this effort as it considers how computing and data science skills contribute to hiring in industry.

Prof. Albrecht Karle (far right) and BoV members inspect a Digital Optical Module (DOM) under development for the Second Generation of the IceCube neutrino observatory being fabricated at PSL.

Another distinctive of this meeting was a set of faculty engagement sessions on the topic of highlighting the many accomplishments of the Department. Simply put, the Board of Visitors is looking for ways to "brag" on the Department for the excellent research and teaching that are happening every day. Professors Halzen, Saffman, Black and Dasu put forward numerous avenues for the Board to pursue. I, for one, found this exchange very helpful. Many thanks to Professor Dasu for facilitating.

A special feature of this year's fall meeting was several events held jointly with the Astronomy Board of Visitors. We shared best practices informally over dinner and jointly visited the University of Wisconsin Physical Sciences Laboratory (PSL). Thanks to Craig Heberer, Dan Koellen, PSL Director Terry Benson, and Professors Forest, Karle, and Dasu, and Aimee Lefkow for making the event a great success.

BoV activities are not limited to the bi-annual meetings. For example, on June 22nd, a group of Physics alumni and supporters visited Lawrence Berkeley National Laboratory in Berkeley, CA. UW–Madison Physics Professor Pupa Gilbert led a tour of experiments from researchers all over the world. We saw Professor Gilbert's own experiment and even met a UW undergraduate working with her for the summer. Afterward, we enjoyed dinner in Berkeley. Thank you to Professor Gilbert for hosting our group.

The BoV continues to be committed to financial support for the Department. We encourage all alumni and friends to join us and consider donating. We especially want to encourage first time donors to use the Day of the Badger in 2024 to start their personal journeys in giving back to a Department that has given us all so much. Please promote on your social media channels to make visible the backing of our great university and physics department.

Physics alumni and supporters visited Lawrence Berkeley National Lab in June, where Prof. Pupa Gilbert (third from right) gave a tour and discussed her research. UW–Madison undergraduate Isabelle Marie LeCloux (second from right) and LBNL postdoc Cristina Castillo Alvarez (right), both in Gilbert's group, helped lead the tour.

Day of the Badger returns
April 16-17, 2024!
dayofthebadger.org

Distinguished Alumni Awards

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

Ann Silversmith, MS '81

By Prof. Emerit Chun Lin

Ann earned her BS degree from Oberlin College, master's degree at UW-Madison, and completed her doctoral work at Australian National University. She joined the faculty at Hamilton College in 1989 and remained there until her retirement. In addition to teaching physics classes at all levels, she built a research lab for studying optical processes in rare-earth based materials. Over 27 years she has worked with some 50 undergraduate students on their thesis research resulting in a very impressive list of publications. Her grandfather, Selig Perlman, was a Professor of Economics at UW-Madison. Her uncle, David Perlman was at one time Dean of School of Pharmacy here.

Steve Nahn '92

By Prof. Kevin Black

Steve Nahn earned his bachelor's degree in physics from UW-Madison in 1992 and worked with Prof. Dan McCammon on designing rocket experiments and a cryogenic system made to withstand the launching and return conditions that has been in operation for 30 years. He received his PhD working with Prof. Peter Fisher at MIT making precision measurements of W-boson processes at LEP. He then moved to Yale as a postdoc where he helped design the upgraded CDF tracker and made measurements of b-cross cross-sections. Following Yale, he moved to MIT as an assistant professor where he worked on the design of the CMS silicon tracker and on the discovery of the Higgs boson. Finally, he moved to his current position as a senior scientist at FNAL where he has managed both the phase-1 and HL-LHC CMS upgrade projects with a combined budget exceeding 500 million dollars.

Alumni Updates

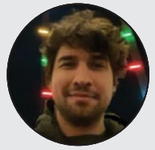
Matthew Vanderhill, PhD '74 *retired in May 2023 after 45 years with MIT Lincoln Laboratory working on radar and infrared systems.*

James Sowinski '77, MS '83, PhD '84*, writes, "I enjoyed visiting the Department this last summer for Willy Haeberli's Memorial Symposium. It was a wonderful memorial to Willy and a great opportunity to catch up with many colleagues. I have recently retired from the Office on Nuclear Physics at DOE, where I was the Program Manager for Nuclear Physics Facilities for the past 12 years. My wife and I have returned to Bloomington, Indiana where I carried out nuclear physics research for 26 years at the Indiana University Cyclotron Facility.*

Matt Bernstein, PhD '85 *will be retiring in February 2024 after 11 years at GE Medical Systems and then 25 years at Mayo Clinic. He says, "Hope to catch up with some friends — I'd love to hear from you!"*

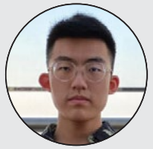
Welcome, Incoming PhD Class of 2023!


Ruaa Al Harthy


Kemal Atay


Ayshea Banes


Mace Bishop


Haotian Cao


Miguel Castelan Tanner


Gavin Chase


Hassan ElSayed


Sam Farrar


Raheem Hashmani


Rupesh Kannan Ramachandran

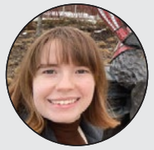

Mason Kennedy


Daniel King

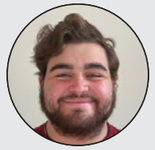

Anderson Lai

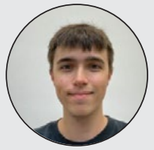

Tianyi Li


Joyce Lin


Alicia Mand


Tali Oh


Dominic Seidita


Colin Stewart


Cate Sturner


Ameya Thete


Lael Verace


Anirudh Yadav


Zizheng Yang


Shihui Zang

Welcome, Incoming MSPQC Class of 2023!


Shoufil Abdul Kareem Subaida


Jason Baer

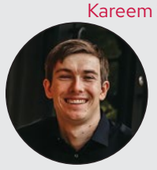

Paul Buttles


James Fitzwater


Paul Franco


Summer Gruber


Tianshen He


Simeon Ignace

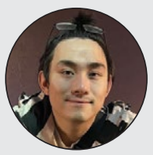

Salizhan Kylychbekov


Scott Lynch


Vishal Madhavaram


Vinay Swami


Ian Nanez


Yujiang Pu

Yasif Rahman

Matthew Riccio

Tyler Schmaltz

Georgia Stricklen

Songtai You

Jiahao Zhao

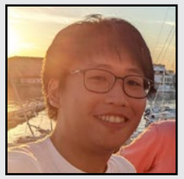
Runshi Zhou

2023: The Year in Photos

Top row: Physics had three winners in the UW–Madison Cool Science Images contest this year. (left) Jacob Scott won for his image of the Saffman group's glowing neutral atom quantum computer setup. (center) Aedan Gardill, PhD '23 won for his SciArt portrait of Marie Curie, who is invisible until revealed by a polarizer. (right) Jimena González and Prof. Keith Bechtol won for their arrayed image of gravitational lensing. **Second row**: Take a bow, Prof. Sprott! The Wonders of Physics celebrated its 40th season with a show that ceremoniously passed the baton to outreach manager Haddie McLean. **Third row**: After a hiatus, the department celebrated spring commencement with a celebration of new Physics graduates. (left) We held the first department PhD ceremony in many years, and (right) welcomed the opportunity to restart our undergraduate event. **Bottom row**: (left) The inaugural Graduate Student Research Colloquium was held this spring. Here, Vedant Basu and Jessie Thwaites co-present IceCube neutrino data. (center) The Gender Minorities and Women in Physics group celebrated Marie Curie's birthday with a paint night. (right) Priyanka Guptasarma (teal shirt) works with a future physicist on an air pressure demo at the annual Juneteenth celebration at Penn Park.

2023 AWARDS & SCHOLARSHIPS

GRADUATE AWARDS



Alan & Arline Paul Award: Jacky Yip

The Alan M. and Arline B. Paul Physics Fellowship is for graduate scholarships in memory of Walter Max Borer, MS '37. Jacky Yip studies cosmology, theoretical high energy physics, and data science methods. Apart from formal theoretical research for physics, an intermediate goal of his is to apply physics methods to develop machine learning theories. With AI rapidly advancing, it is not only an academic interest to understand how and why these machine/deep learning models work, but also to comprehend the limits of AI and its impact on our society's future.

Karl Guthe Jansky & Alice Knapp Jansky Award: Jessie Thwaites

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; Alice Knapp Jansky received a BA in sociology in 1929. Jessie Thwaites conducts research in high energy astrophysics with IceCube. They search for transient astrophysical neutrino sources, both in real-time and in archival searches. They use multi-messenger techniques to search for neutrinos from exciting sources, such as compact object mergers which produce gravitational waves, and GRB 221009A, the brightest gamma-ray burst of all time.

Albert R. Erwin, Jr & Casey M. Durandet Award: Anna Cooleybeck

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. Anna Cooleybeck is an experimental particle physicist whose current research area is neutrino oscillations, where a neutrino of one lepton flavor can change to a different flavor after traveling some distance. Her current project is an analysis of two neutrino oscillation experiments, MINOS and NOvA. Analyzing these two experiments together allows her to understand the parameters governing neutrino oscillation with higher precision.

Charles Mendenhall Award: Sam Norrell

The Charles E. Mendenhall Fellowship supports a graduate student in experimental physics. Sam Norrell works in the Saffman group in the field of quantum computing. Quantum computers have the potential to solve problems that even the world's largest supercomputers cannot break. Despite this promise, no sufficiently large quantum computer has yet been constructed. He hopes the Saffman group can be among the first to create such a device. Unlike companies such as Google and IBM, their laboratory utilizes individual atoms as the basic unit of computation.

DEPARTMENT TEACHING AWARDS

Joseph R. Dillinger Award for Teaching Excellence
Bradley Kumm

Best TA Spring 2022
Stephen McKay

Best TA Fall 2022
Shu Tian Eu

Rookie of the Year
Owen Eskandari

Outstanding Undergraduate Assistant
Chloë Edgington

UNDERGRADUATE AWARDS

Dr. Maritza Irene Stapanian Crabtree Award: Brooke Kotten

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. Brooke Kotten currently does research with CIRES/CU Boulder to improve real-time solar flare location detections for better space weather alerts. Space weather phenomena such as coronal mass ejections can overload power grids, cause electrical blackouts, and impede radio transmissions. The products of her work are used in real-time by space weather forecasters. She hopes to continue her studies in space weather or solar physics in graduate school.

Bernice Durand Research Scholarship: Jenna Karcheski

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. It is named in honor of the late UW–Madison Physics Professor Emerit Bernice Durand. Jenna Karcheski currently does research work on all scales of the universe, including the exoplanetary, interstellar, and extragalactic subfields. They are working to classify a large dataset of intergalactic "absorbers" (gas clouds) and create maps of the absorbers and the galaxies that surround them. Jenna also works at the local Bell Burnell Observatory to confirm exoplanet transits with a group of undergraduates.

Fay Ajzenberg-Selove Award: Lucy Steffes

The Fay Ajzenberg-Selove Scholarship Fund supports undergraduate women majoring in or planning to major in astronomy or physics. Lucy Steffes is currently most interested in the chemistry in the Interstellar Medium. She has one research project at UW–Madison for which she examines the Magellanic Stream in the diffuse Interstellar Medium to calculate the upper limits of a series of molecules. This allows her to make conclusions about the small scale environments of potential future star forming regions. She also works on a second project at the Green Bank Observatory, where she was an REU student. Lucy is a Hilldale Fellow and a Goldwater Scholar.

Liebenberg Family Scholarship: Andrii Hopanchuk

The Liebenberg Family Scholarship is awarded annually based on merit to a junior majoring in physics. Andrii Hopanchuk currently works with Pupa Gilbert on measuring average concentrations of chemicals using a picture and Matlab. He is also interested in modeling and theory. Outside of physics, Andrii enjoys reading, and playing and listening to music.

INGERSOLL AWARDS

Ingersoll Prizes are awarded to students who have done the best work in the undergraduate courses

Physics 249
Mihir Manna

Physics 249
Shaula Yan

Physics 249
Joshua Stadler

Overall 247-248-249
Erica Magee

THAXTON FELLOWS

The Hubert Mack Thaxton Fellowship, named after Dr. Thaxton, MA '36, PhD '38, seeks to provide more equitable access to physics research experiences for undergraduates and related fields. Thaxton Fellows collaborate with a faculty mentor in the department on a research project aligned with the students' interests.

Vanessa Bello Ruiz
Nadia Talbi
Alex Tellez
Ella Sabo

WONDERS OF PHYSICS OUTREACH FELLOWS

The Wonders of Physics Outreach Fellows program accepts PhD students who are interested in and committed to conducting physics outreach. Fellows receive mentoring in outreach from professional outreach staff and participate in one or more outreach events over the course of the year.

Braden Buck
Delaney Butterfield
Zachary Curtis-Ginsberg
Owen Eskandari
Aubrey Houser
Zachary Jerzyk
Sam Kramer
Aakankshya Mishra
Alysa Rogers
Julia Sheffler
Mitanshu Thakore
Hannah Woodward

OTHER STUDENT, POSTDOC AWARDS & HONORS


NSF Graduate Research Fellowship: Samuel Hori, Alysa Rogers, Emil Pellett (*not pictured*)

The National Science Foundation Graduate Research Fellowship Program recognizes and supports outstanding graduate students in NSF-supported STEM disciplines who are pursuing research-based doctoral degrees. The Fellowship offers three years of support. PhD students Samuel Hori and Alysa Rogers and physics major Emil Pellett '23 received the 2023 GRFP. PhD student Spencer Weeden received an honorable mention.

L&S Teaching Mentor: Sam Kramer, Justin Marquez

L&S Teaching Mentors serve as facilitators at the annual L&S Fall TA Training event and provide mentorship throughout the semester. Those selected to be Teaching Mentors have not only a proven track record of excellence as educators, but also a strong desire to share their experience and mentor new TAs navigating their first year.


Dorothy Powelson Teaching Assistant Award: Soren Ormseth

UW–Madison employs over 2,300 teaching assistants (TAs) across a wide range of disciplines. Their contributions to the classroom, lab, and field are essential to the university's educational mission. To recognize the excellence of TAs across campus, the Graduate School, the College of Letters & Science (L&S), and the Morgridge Center sponsor these annual awards. Soren Ormseth was one of 21 graduate students honored this year.

David Swanson Award: Jimena González

The David Swanson Award is bestowed annually upon one or more former students of the Open Science Grid (OSG) User School who have subsequently achieved significant distributed High Throughput Computing-enabled research outcomes. It is given in honor of Swanson, a longtime champion of and contributor to the Open Science Grid (OSG), who passed away in 2016. González was selected as one of two recipients of the 2023 Award.

Hilldale, Sophomore Research Scholars: Dhanvi Bharadwaj, Erica Magee, and Elias Mettner



The Hilldale Undergraduate/Faculty Research and the Sophomore Research Fellowships provide research training and support to undergraduates at UW–Madison. Bharadwaj, a Hilldale Fellow, is a physics major conducting research with Ramathasan Thevamaran in Mechanical Engineering. Sophomore Research Fellow Magee is a mathematics and physics major working with Martin Zanni in Chemistry; Mettner is a physics major working with Abdollah Mohammadi in Physics.

UW–Madison Postdoc Association Excellence in Service Award: Wasikul Islam

The Postdoc Excellence Awards recognize current postdocs on the UW–Madison campus that contribute their time, knowledge, energy, and enthusiasm to mentoring, teaching, and service. Wasikul Islam, a postdoc in Sau Lan Wu's group, was recognized by the UW–Madison Postdoc Association with an Excellence in Service Award. He was nominated for his science outreach activities, promotion of basic sciences, volunteering, and mentorship to undergrad Physics students through various non-profit organizations including the American Physical Society.

Focus on:

Student Internships & Fellowships

Abby Bishop

5th-year PhD student

Inter-University Institute For High Energies, Brussels, Belgium

2023-24

Astroparticle physics

"I've started a new project studying how the Askaryan Radio Array observes cosmic rays, and I've been able to help set up Radio Neutrino Observatory in Greenland mainboards for installation next summer. Being able to work with so many of my collaborators, who I only ever knew over Zoom and Slack, has been tremendously fruitful."

Muneeza Munawar

Senior undergrad

SLAC National Accelerator Laboratory, Menlo Park, CA

Summer 2023

Accelerator physics

"The interdisciplinary nature of research between scientists, engineers, and machinists in my project taught me a lot about collaboration in research and working at a national lab, and it fueled my desire to take part in larger projects in the future."

Joyce Lin

1st-year PhD student

Space Telescope Science Institute (STScI), Baltimore, MD

Summer 2023

Astrophysics, machine learning

"I applied to STScI's Space Astronomy Summer Program (SASP) because I wanted to contribute to their extraordinary research and mission of advancing the bounds of our astronomical knowledge. From this internship, I learned so much about astrophysics outside of my field of expertise."

Ariela Strimling

MSPQC student

American Family Insurance, Madison, WI

Summer 2023

Quantum computing algorithms

"Researching state-of-the-art algorithms gave me an opportunity to dive deep into new tools that the industry is interested in."

Ben Harpt

6th-year PhD student

Intel, Hillsboro, OR

Spring 2024

Semiconductor quantum computing

"I know that I want to go into industry but there are different ways to do that. I think this internship will give me a good opportunity to see what the research I do now looks like at the next level and decide if that's something I want to pursue as the next step in my career."

Zain Abhari

3rd-year PhD student

SPring-8 Angstrom Compact free electron LAser (SACLA), Japan

Fall/Winter 2023

X-ray imaging and spectroscopy

"My goal after the PhD is to work at one of these large-scale facilities, specifically the X-ray free electron lasers, and there's only six of them right now in the world. If I can get my foot in the door in Japan, or get the experience to then help me with any of the other ones, that would be pretty awesome."

Does your company offer internships?

We are always looking to connect with alumni to help support physics students in their career development. Please contact Evan Heintz to discuss opportunities.

eheintz@wisc.edu
608.263.7450

PHYSICS DEGREES AWARDED

Undergraduate Degrees

Fall 2022

Daniel Laws
Marco Lopez
Robert Rozite
Samuel Smith

Spring 2023

Isaac Barnhill
John Batarekh
Catherine Beckman
Samuel Benda
Philip Bjorklund
Charles Bray
Haotian Cao
Henry Conway
Daniel Cove
Patrick Eichler
Alec Epstein
Marcus Graham
Maxwell Hanson
Kaytlin Harrison
Samuel Haslow
Connor Howe
Elyse Incha
Haoyi Jia
Elisa John
Isaac Koehler
Juhun Kwak
Eric Leonard
Yizhou Liu
Eric Marquette
Alec Messman
Abhishek Gurunath Mhatre
Drake Miller
Emil Pellett
Brian Putra
Ashling Quinn
Noah Rademaker
Amanda Ready
Brandon Schmall
Tyler Schmaltz
Allyson Sellner
Yuheng Shen
Pierce Stastney
Yuhan Tong
Noah Welke
Briana Wirag

Summer 2023

Hongjun Lin

Bachelor's Degree In Memoriam

Frank Wang

MA/MS Physics Degrees

Matt Cambria
Sergey Gitalov
Ruiyang Feng

MS Physics – Quantum Computing Degrees

Matthew Beede
Manish Kumar Chowdhary
Aidan Dickinson
Turner Entenmann
Louis Farenci
Randall (Hank) Greenburg
Hunter Hamby
John Hawthorne
Georgia Mitchell
Matthew Myers
Trystan Smith
Kevin Tactac
Jiaxi Xu
Anirudh Yadav
Yukun Yang
Jinyu Zhou

Doctoral Degrees

Fall 2022

Edward Basso
Advisor: Chung

Weng-Him Cheung
Advisor: Caldararu, Shiu

Jiarui Gong
Advisor: Ma, Rzchowski

Samuel Greess
Advisor: Egedal

Jithin Madhusudanan Sreekala
Advisor: Dasu

Sarah Mancina
Advisor: Karle

Cayla Stiffler
Advisor: Gilbert

Bunheng Ty
Advisor: Hanson

Zhaoning April Yu
Advisor: Kats

Spring 2023

Praful Gagrani
Advisor: Baum, Dasu

Chuanhong Vincent Liu
Advisor: McDermott

Susan Sorensen
Advisor: Walker

Alex Wang
Advisor: Wu

Colin Whisler
Advisor: Brar

Summer 2023

Chen-Hsun Chan
Advisor: Wu

Yujun Choi
Advisor: Joynt

Aedan Gardill
Advisor: Kolkowitz

Urvashi Gupta
Advisor: Sovinec

Mrunal Korwar
Advisor: Bai

Stephanie Kubala
Advisor: Den Hartog

Wilson Lough
Advisor: Saffman

Scott Lucchini
Advisor: D'Onghia

Manuel Silva
Advisor: Karle

Leah Tom
Advisor: Friesen

GIFT GIVING GUIDE

PRIORITY FUND: The Newton Fund

Administered by the Department Chair, this fund aids the department in its research, teaching, and public service roles. The department of physics is in the midst of hiring many new faculty in the wake of the pandemic. There are tremendous opportunities across the amazing breadth of research in our department. Your donation will help launch the research, teaching, and service of the next generation of Wisconsin physics faculty and students.

Please visit ***go.wisc.edu/NewtonFund*** or scan the QR code 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

Phyllis Jane Fleming Graduate Student Support Fund

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

Robertson Leach Graduate Student Fund

Graduate Student Recruiting Fund

Special Physics Graduate Support Fund (Anderson-Huber Fellowship)

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 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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