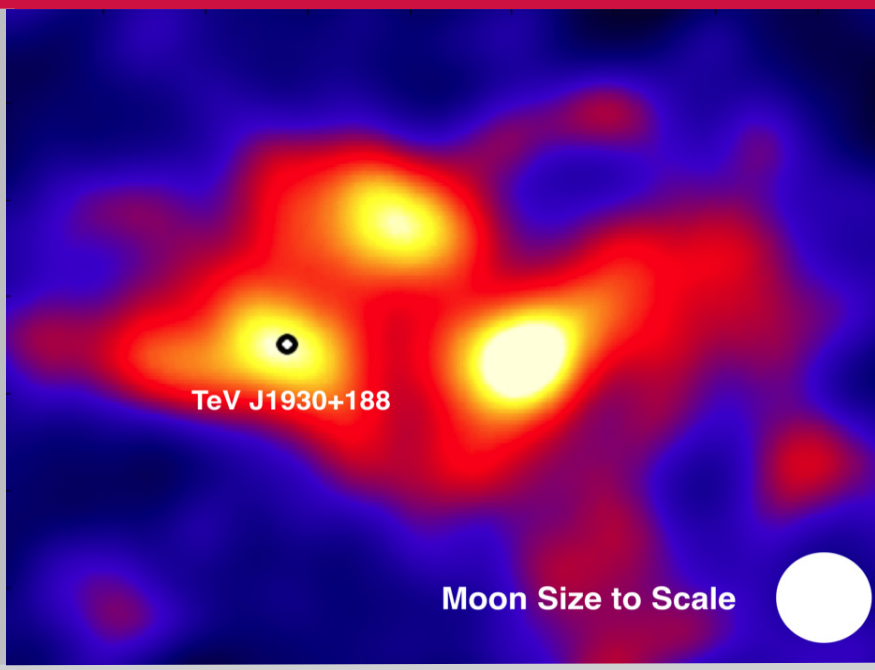
The Wisconsin Physicist



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Greetings from the Chair

Dear Alumni and Friends

Albrech Karle - Department Chair

We are looking back at a great year in 2016. The department continues to be a vibrant place for physics across a wide range of areas. This new edition of the Wisconsin Physicist will give you an opportunity to catch up with recent developments in research, education, awards and events in our department.

Our new assistant professors have settled in, started their research and begun teaching. Kim Palladino has joined us from SLAC to search for dark matter with the LZ (Liquid Xenon) experiment. Alex Levchenko will be doing research in theoretical condensed matter physics. Victor Brar, who grew up in Middleton, Wisconsin, is setting up his lab in experimental condensed matter physics. We are excited to have succeeded with a senior hire. Lev Ioffe, a renowned condensed matter theorist, is very eager to interact with experimentalists and will greatly strengthen our theory group in that area. In the coming year, we have been authorized to search for at least one assistant professor. Hopefully, we can hire more.

In the 2015/16 academic year, we conducted an extensive strategic planning exercise. The goal of the exercise was to review and formulate strategic priorities for the coming years. We looked at both the short and the long term. A committee was formed that worked throughout the academic year. At the end of the spring semester, a departmental retreat was held to discuss the priorities as presented by groups and individuals to the faculty. The plan is broad-based and covers research, teaching, space and organizational aspects of the department.

Priorities include but are not limited to 1) experimental neutrino physics with an orientation towards the Fermilab-based neutrino program, which has been determined to be a national priority in particle physics, 2) atomic, molecular, optical and quantum physics, and 3) theoretical and experimental cosmology and astrophysics. Other areas include condensed matter physics, high-energy physics and others. Future cluster hires are envisioned in computational physics, biological and soft condensed matter, and possibly even exoplanets.

Innovations in the instructional program were reviewed with the goal of meeting the increasing teaching demands as we update and expand our offerings for physics majors. For the service courses, the initiative towards active learning, led by Prof. Timbie, is in full swing. The goal is to transform Physics 103 and 104, courses that are attended by more than 1,500 students per year, to an active learning format within two years.

We congratulate Professor Ellen Zweibel on receiving a Vilas Distinguished Achievement professorship. Moreover, Dr. Zweibel has been awarded the prestigious Maxwell Prize for Plasma Physics. Please enjoy Ellen's article later in this issue.

Also receiving a Vilas Distinguished Achievement professorship is Professor Mark Eriksson. We congratulate him as well. Enjoy his article explaining his research.

If you would like to know more about the meaning of IceCube's cosmic neutrino research, you are in luck. In this issue, Prof. Francis Halzen shares his insights on the IceCube results, which he puts in the larger context of multimessenger astrophysics.

The 15th annual awards banquet was held in May 2016. The continued generosity of our alumni and friends allows us to present many awards to outstanding students. You can read more about the awards banquet on p. 13.

We are pleased to maintain our tradition of recognizing alumni with the presentation of four Distinguished Alumni Awards.

Howard Baer received his Ph.D. from UW–Madison in 1984. He worked at CERN for one year in 1985 and at Argonne National Laboratory for two years and taught at Florida State University until 2008. Since then, he has been a professor at the University of Oklahoma.

Siu Au Lee obtained her B.S. degree at UW–Madison in 1970 and her Ph.D. at Stanford University in 1976. Her current interests include quantum computing and laser manipulation of atoms. She has been instrumental in establishing the W.M. Keck Labora¬tory for Quantum Computing at the Colorado State University.

Stephan Meyer is a professor at the Enrico Fermi Institute at the University of Chicago and is affiliated with the Kavli Institute. After he received his Ph.D. from Princeton in 1979, he went on to take pioneering measurements of the cosmic micro¬-wave background radiation from the ground at the South Pole, from scientific balloons, and from space.

Marv Ebel was recognized with the Distinguished Service Award. He received his Ph.D. from Iowa State University in 1953 and did postdoctoral research at Yale University with Gregory Breit. In 1956, he joined the high-energy theory group at the UW Physics Department. His research included electron fast ion interactions and high-energy neutrino reactions. He has served as department chair and for many years was associate dean of the Graduate School.

The Physics Department Board of Visitors met twice in 2016. The Board of Visitors continues to help us in a number of ways: providing feedback to the department, recruiting graduate students and, last but not least, fundraising.

Whether you are an alum, friend, employee or student, we appreciate your interest in, and loyalty to, the University of Wisconsin–Madison Physics Department. All of the awards given out are based on donations. As an example, the Physics Alumni Graduate Support Fund allows us to give fellowships and supplement the stipends of incoming graduate students. The Newton Fund helps the department with academics and research and in many other ways. Thanks for your support of the Ingersoll Museum, for which we are making plans to celebrate 100 years in 2017.

You can help by donating online to the Physics Department at: http://www.physics.wisc.edu/giving. Please see page 19 for more ways to give.

I sincerely thank our generous alumni and friends who have financially supported the department. This support is truly our margin of excellence.

Stay Connected!

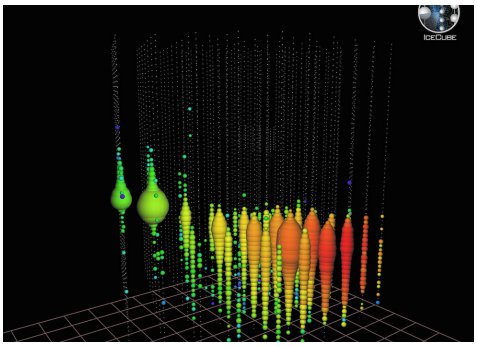
Please continue sending us your professional and personal news!

We will be happy to include updates from alumni and friends in the Wisconsin Physicist.

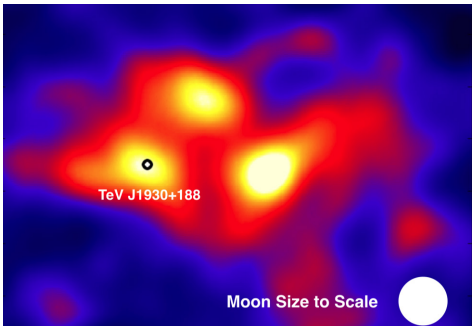
- **Do you receive email from the department? Sign up to receive our weekly seminar emails: https://www.physics.wisc.edu/twap/ click on " Subscribe to receive email announcements of events "**
- **Send your updates to: info@physics.wisc.edu**

News in Physics 2016

BadgerLoop wins 3rd in SpaceX's Hyperloop Pod Competition
Thursday, February 4, 2016
A team of University of Wisconsin—Madison engineering students won 3rd place overall in a worldwide competition to design a pod for shuttling people on a futuristic high-speed transportation system known as the Hyperloop. The team will build its test pod in a workspace in Chamberlin Hall. Professor Duncan Carlsmith awarded BadgerLoop a mini grant from the Garage Physics makerspace to develop and prototype the pod system.



NSF renews IceCube maintenance and operations contract
Wednesday, March 30, 2016
The National Science Foundation announced on March 30, 2016 that it has renewed a cooperative agreement with the University of Wisconsin–Madison to operate IceCube. The five-year, $35 million award entails the continued operation and management of the observatory located at NSF's Amundsen-Scott South Pole Station. In 2013, the IceCube Collaboration reported the first detection of high-energy cosmic neutrinos, opening a new astronomical vista on the universe and on some of its most violent phenomena.



HAWC reveals new look at the very high energy sky
Monday, April 18, 2016
Scientists operating the High Altitude Water Cherenkov Observatory (HAWC) presented a new survey of the sky using the highest energy gamma rays ever observed. "HAWC gives us a new way to see the high-energy sky," said Jordan Goodman, USA-spokesperson of HAWC.

Ellen Zweibel and Mark Eriksson were awarded Vilas Distinguished Achievement Professorship
Thursday, May 19, 2016
This award recognizes distinguished scholarship as well as standout efforts in teaching and service.

Walt Wigglesworth has passed away
Wednesday, July 13, 2016
Walt Wigglesworth, former student/staff shop supervisor (02/20/1995-01/22/2002), and for whom our stockroom is named "Walt Mart," has passed away.

News in Physics 2016

Zweibel wins 2016 Maxwell Prize for Plasma Physics

Tuesday, July 26, 2016

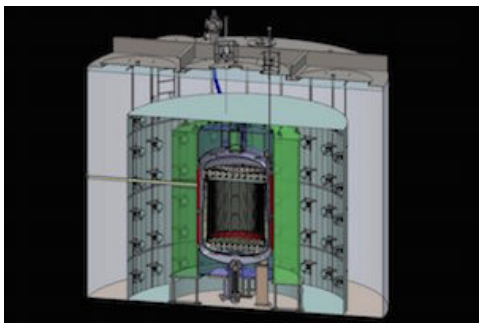
Ellen Gould Zweibel has won the American Physical Society's 2016 James Clerk Maxwell Prize for Plasma Physics.

The prize citation recognizes Zweibel for "seminal research on the energetics, stability and dynamics of astrophysical plasmas, including those related to stars and galaxies, and for leadership in linking plasma and other astrophysical phenomena."

Dan McCammon receives the 2016 NASA Exceptional Public Service Achievement Medal

September 14, at the NASA/Goddard Space Flight Center

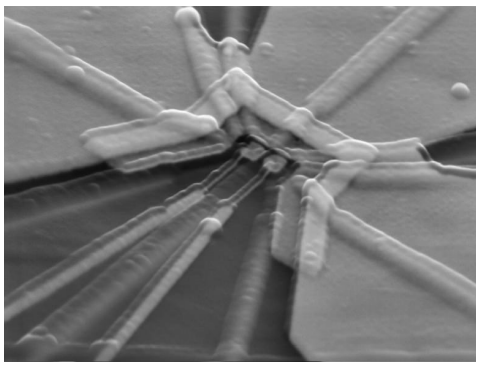
Dr. Dan McCammon is being awarded a 2016 NASA Exceptional Public Service Achievement Medal in recognition for pioneering work in the study of the celestial diffuse x-ray background and the development of low temperature x-ray spectrometers that have enabled numerous NASA projects.



Construction of world's most sensitive dark matter detector moves forward - Kim Palladino, Shaun Alsum

Tuesday, September 27, 2016

Assistant Professor Kim Palladino joined the department last year to bolster Wisconsin's involvement with the LZ experiment. Prof. Palladino secured the support of the US DOE promptly, while she was on research leave at SLAC to lead the construction and commissioning of the LZ test system at SLAC laboratory, with graduate student Shaun Alsum. PSL engineer Jeff Cherwinka serves as the chief engineer of the LZ experiment.



Mark Eriksson's grant leads on project to get UW getting electron beam lithography system for nanotech research

Thursday, October 13, 2016

Research projects statewide, from electronics to optics and medicine, are set to benefit from a new system coming to UW–Madison that will use electron beam lithography (EBL), a specialized technique for creating extremely fine patterns — in some cases more than 5,000 times narrower than the diameter of a human hair.

Alumni News

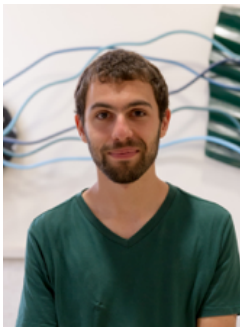
Robert M. St. John (Ph. D. 1954) was honored by the Physics Department through the establishment of the Robert M. St. John Graduate Fellowship financed by an anonymous donor. After completing his doctoral research supervised by Professor J. G. Winnas, St. John joined the faculty at the University of Oklahoma where he remained until his retirement in 1990. He is well known for his seminal research work in the field of atomic collisions and gaseous electronics. He served as the Chairman of the Engineering Physics program for15 years.

Support Funds

Support Funds
By Robert Joynt

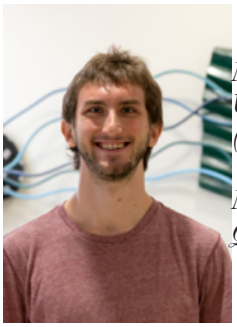
The 2016 incoming graduate class of Physics Ph.D. students arrived, and classes started in September. It is a big class, 41 students from the US and around the world chosen from 451 applicants. We are happy that the department remains such a desirable school for the top B.Sc. physics undergrads, and we think this is one of the strongest classes in recent history.
Our success is due in no small part to generous donations from our alumni and other friends. Competition from other schools for these students is very intense, and the financial incentives in the form of fellowships that we can offer these students make Madison even more attractive. In recent years, two funds have been established that are specifically devoted to recruiting, the Physics Department Alumni Fund, established by the Physics Board of Visitors, and the L. Wilmer Anderson and David Huber Graduate Support Fund, established by an anonymous faculty member. Other more longstanding funds that offer financial support to graduate students are the Van Vleck Fund, the Herb Fund, the Browne Fund, and the Firminhac Fund for women students. Here we highlight the Fellows receiving awards from these newly established funds.

The honorees this year are:



Aaron Batker-Pritzker of Harvey Mudd College ($10,000 Fellowship)

Aaron is interested in Condensed Matter Theory



Michael Cervia of the University of Chicago ($10,000 Fellowship)

Michael is interested in Quantum Computing

Joseph Jepson of Utah State University ($10,000 Fellowship)

Joseph is interested in Theoretical Plasma Physics

Wilson Lough of Northern Arizona University ($10,000 Fellowship)

Wilson is interested in Particle Theory

Jonathan Nikoleyczik of Harvey Mudd College ($10,000 Fellowship)

Jonathan is interested in Neutrino Experiment

We believe that the future is bright for these students. Furthermore, having students of this quality in the program raises the overall level of the research and education efforts in the department. Thanks again to our generous donors!

The BadgerLoop

BadgerLoop

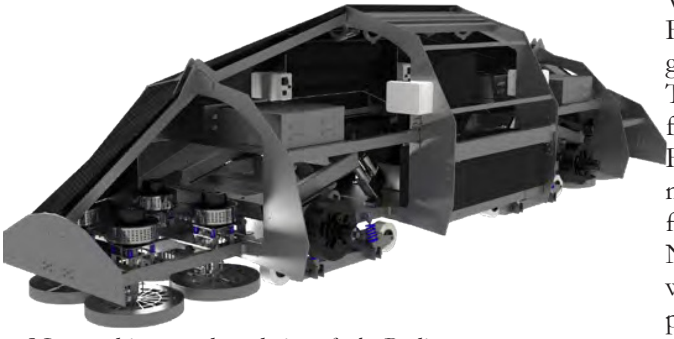
by Duncan Carlsmith

The BadgerLoop team is constructing a prototype Hyperloop transport vehicle using magnetic levitation and acceleration devices developed with support from a Garage Physics/Venturewell minigrant for innovation and entrepreneurship. The team has involved over 100 undergraduate participants majoring in Physics, AMEP, computer science, and various engineering disciplines. Now incorporated as a non-profit, it has raised significant funding (see BadgerLoop.com). Since placing 3rd in the SPACEX international Hyperloop design competition in Jan. 2016, held in College Station, BadgerLoop is using space provided by the Physics Department to construct their prototype pod. The August newsletter below describes recent technical progress and outreach.

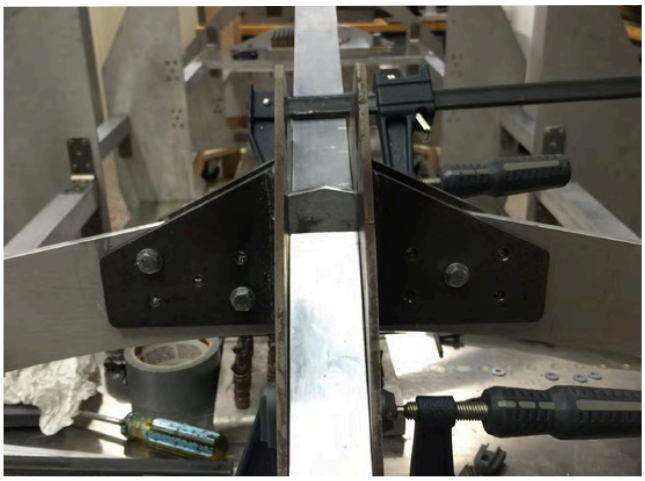
August Newsletter,

BadgerLoop Team,

The news is out! SpaceX has released the official dates when they plan on hosting the Hyperloop Competition. During the weekend of January 27th, 2017, BadgerLoop will be one of 30 international teams in Hawthorne, California testing our pod prototype on their one-mile long test track. More information can be found here: http://www.spacex.com/hyperloop



New and improved rendering of the Pod!



At 1000 kg, it's important that these crane lift points can support the pod as it is transported into the competition tube.

With the extension of the competition, this means more time for BadgerLoop to fully test our systems and produce a fail-safe, passenger-friendly, and scalable pod.

To update you on the current status of our pod, check into these fabrication shout outs:

Back in Chamberlin, team members have been hitting fabrication milestones.. We have recently finished manufacturing multiple carbon fiber test panels to investigate different reinforcement techniques. Now it's time to start making the real panels! The BadgerLoop Pod will feature 36 angled panels in a geodesic design. This will give the pod a strong, aerodynamic outer shell.

The carbon fiber panels will enclose the structure, which has also received a lot of attention this month. The crane lift points have been redesigned and reattached as the structure is being prepared to be sent off for painting. At the competition, the pods will be lifted by the crane into the tube.

Just because school took a pause, doesn't mean our outreach team has! The Engineering Tomorrow's Career camp hosted by the Society of Women in Engineering visited for a short presentation and tour of our space in Chamberlin Hall. The 95 female campers asked lots of excellent questions, and it was a great opportunity to inspire the campers to consider a STEM career!

Our friends at BadgerBOTS also came for a visit in early June. Students were able to see our working space and learn more about our project and the Hyperloop concept! These high school students have a lot of great experience and are amazing peers to work with. We look forward to working with them!

As always, thank you for your continued support of the BadgerLoop team. Be on the look out on our social media pages for details about our big Reveal Event. We hope to see you there!

Sincerely,

Your BadgerLoop Team

Vilas Awards (E. Zweibel & M. Eriksson)

Vilas Award
by Ellen Zweibel

Ellen Zweibel, Photo courtest of E. Leonard Jr.

I'm ending my thirteenth year at the University of Wisconsin as a professor in the Astronomy and Physics Departments with a research program in plasma astrophysics. The UW is a wonderful environment which I'm proud to be a part of.

Plasma astrophysics explores the interaction between ionized matter in the universe and electric and magnetic fields. Sunspots are an excellent example. They tend to come in pairs, and are named for their visual appearance (never look at the Sun without a filter!), but represent a sort of solar hernia formed when a belt of strong magnetic field in the solar interior buckles into an arch that protrudes above the solar surface. Why the solar interior magnetic field organizes itself into strong belts, and why the number of sunspots rises and falls regularly every 11 years, is one of the many unsolved mysteries of plasma astrophysics.

Many astronomers choose their careers as children, and this was the case for me. I had a small telescope, which I lugged around our back yard and looked at whatever was visible through holes in the canopy of trees. In college I was drawn to theoretical astrophysics by a combined carrot and stick approach, the carrot being my love of mathematics and the stick my incompetence with any sort of lab experiment. I was very fortunate, from the beginning of my freshman year, to have wonderful mentors who allowed me to do research that gave a sense of overarching purpose to my days. I work with many undergraduate and graduate students here, and try to do the same for them.

As a college senior, I discovered plasma physics in the form of a set of lecture notes transcribed from a course given by the great astrophysicist S. Chandrasekhar. I loved the application of classical mechanics to the behavior of charged particles, and the application of statistical mechanics to the behavior of many such particles. I studied plasma physics and astrophysics at Princeton University, where I attended graduate school, and where I was introduced to problems that remain unsolved today. There are too many to list, but it's fair to say that whenever a cosmic explosion or particle at relativistic energies is observed, electric and magnetic fields are somehow at work.

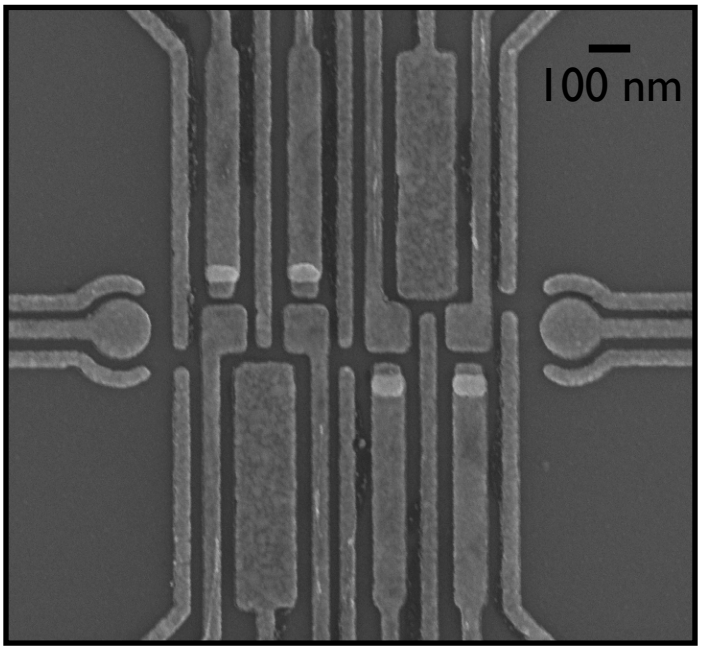
Plasma astrophysics has carried me throughout the Universe, but also into at least the doorway the lab. UW is a pioneer in *laboratory plasma astrophysics,* a relatively new branch of experimental science that is allowing us to look at plasma astrophysics problems in a new way. The synergism between our plasma physics and astrophysics programs, and the research and educational opportunities that it creates, is unique among universities in the US, and perhaps in the world. It is a great pleasure to be able push it forward, and to be recognized for doing so.

Silicon and Germanium: Classic Materials for the New Science of Quantum Information
by Mark A. Eriksson

The science underlying modern information technologies cuts a wide swath through field of physics: lasers power communication around the globe, plasmas and accelerators are critical for semiconductor device fabrication, semiconductors themselves are the backbone of both processors and memory, and superconducting filters help split wireless bandwidth ever more finely. The quantum revolution of the 1920s underlies all of these technologies, from the physics enabling high resolution displays to the very stability of atoms themselves.

Yet today the algorithms we apply to our information – the way we make use of the physical representation of our data – is entirely classical. This limitation is far from a requirement: as early as 1982 Richard Feynman made his now famous suggestion that a computer making explicit use of quantum mechanics could simulate quantum systems very efficiently.

Vilas Award



*The first of two layers of metallic gates forming a quadruple quantum dot in which electrons are trapped in a silicon quantum well 50 nm beneath the surface.**

Since 2001, and motivated by enormous advances in quantum information theory, students and postdocs in our department have performed experiments to understand and to develop the physics of semiconductor devices that make explicit use of the rules of quantum mechanics. The quantum bits (qubits) they study are formed in quantum dots: devices that confine electrons in all three dimensions to nanometer-scale regions inside layered semiconducting crystals, formed of silicon and germanium, and grown with near monolayer precision in the group of Professor Max Lagally.*

Since that early beginning, Physics Department students have performed numerous experiments, learning to confine individual electrons inside Si/SiGe quantum dots, measuring the orientation of a single spin inside such dots, and putting a single electron into a superposition state where – for a few moments in time – neither the students nor the environment know in which dot a measurement will reveal the electron to be.

Theory too has played a pivotal role in semiconductor quantum information in our department, led by Professors Susan Coppersmith, Robert Joynt, Maxim Vavilov, and senior scientist Mark Friesen. Particularly prominent was the conception in 2012 of a new type of semiconductor qubit: the quantum dot hybrid qubit. This qubit is composed of three electrons in two neighboring quantum dots, and it has the special property that two of its low-lying states – the qubit states – are both long-lived and fully controllable with ac electric fields.

Since this proposal, graduate students and postdocs in our department have realized full quantum control of this qubit, demonstrating Ramsey oscillations at a rate of over 10 GHz and Rabi oscillations as fast as 200 MHz.

Our Department's research and teaching on quantum information extends well beyond semiconductors. Professor Mark Saffman and his students and collaborators are studying the manipulation of neutral atom qubits, and Professor Robert McDermott leads a program on superconducting qubits. The breadth and depth of this activity led the Department of Physics to take the lead in establishing the Wisconsin Institute for Quantum Information (WIQI), which provides support for research and education on quantum science and technology at the university.

While WIQI builds on and supports the many commonalities, the physical details of neutral atom, semiconductor, and superconductor-based qubits are extremely different. In fact, the physics of superconductors and semiconductors is so different that the Nobel committee awarded Dr. John Bardeen (UW-Madison, class of '28) the Prize in physics not once but twice: first for the discovery on the semiconductor transistor effect (1956) and second for what we now call the BCS theory of superconductivity (1972).

Phenomena that are so different offer great potential if they can be brought together. Department of Physics graduate students, spear-headed by second-year students Nathan Holman and JP Dodson, are working intensively to couple superconductor and semiconductor quantum circuits to one another, with the goal of using a superconducting intermediary to generate entanglement between distant pairs of semiconductor qubits.

For more on the breadth and depth of quantum science at UW-Madison and the Department of Physics, check out http://wiqi.physics.wisc.edu. And when your colleagues ask just how things are in Madison these days, you can fill them in: at 0.008 degrees above absolute zero, the silicon qubit lab in Chamberlin Hall – the coldest spot in Wisconsin – is a pretty chill place to do some physics.

**Figure simplified and adapted from, "State-conditional coherent charge qubit oscillations in a Si/SiGe quadruple quantum dot," D. R. Ward, Dohun Kim, D. E. Savage, M. G. Lagally, R. H. Foote, Mark Friesen, S. N. Coppersmith, and M. A. Eriksson, npj Quant. Inf. 2, 16032 (2016) (https://creativecommons.org/licenses/by/4.0/).*

IceCube and the Era of Multimessenger Astrophysics

Francis Halzen

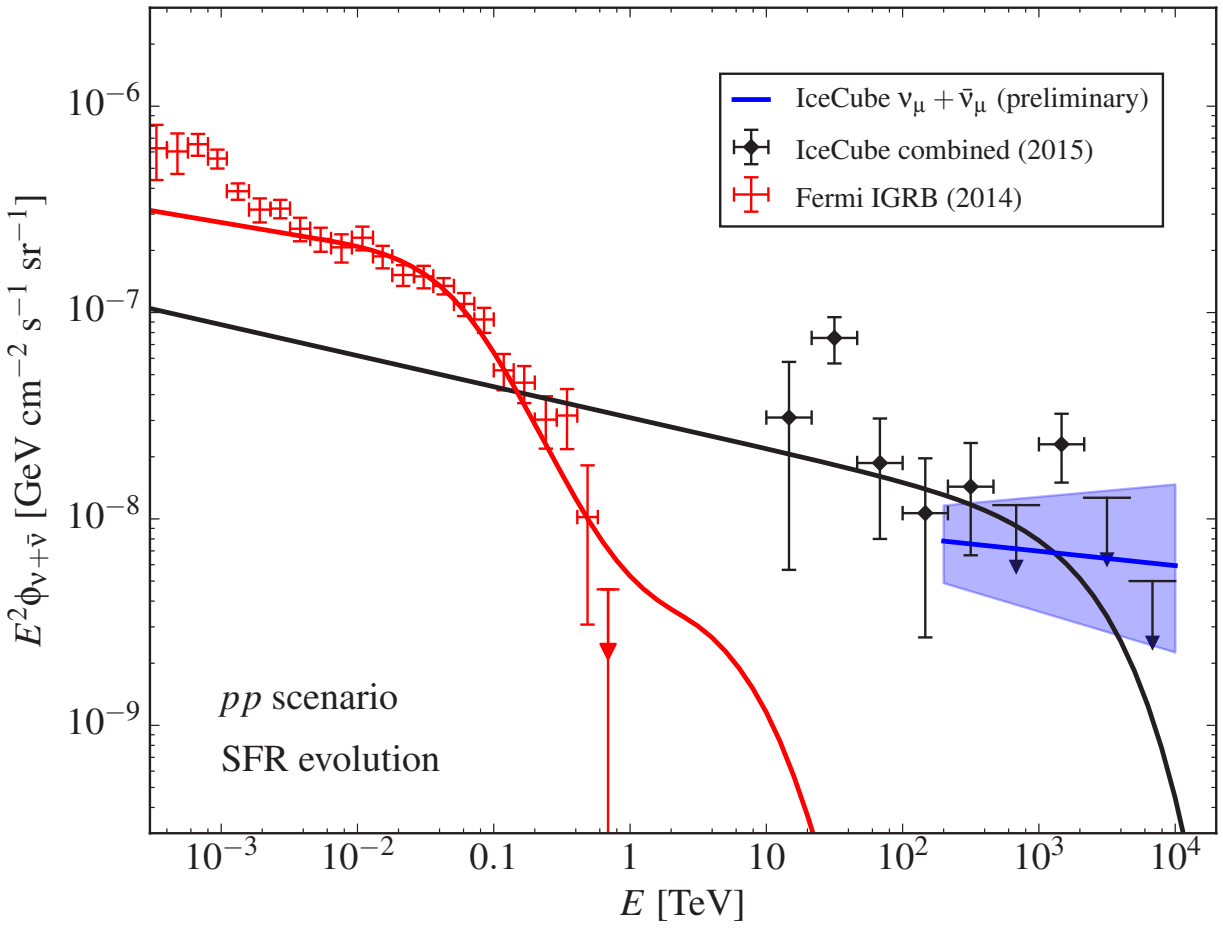
With the commissioning of the IceCube and Advanced LIGO facilities, we are able to observe the universe for the first time using three distinct astronomical messengers. In addition to photons, from radio waves to gamma rays, we can now simultaneously observe the sky with gravitational waves and high-energy neutrinos. This new era of multimessenger astrophysics will offer a unique view of our universe and provide powerful insights into the workings of some of the most energetic and enigmatic objects in the cosmos. In fact, initial findings have been astonishing. The first direct observation of a gravitational wave may become a footnote in history to the fact that thirty-solar-mass black holes exist to generate its energy. Their mere existence with such a mass challenges our understanding of the universe.

When I was a graduate student, research on black holes, and cosmology in general, was boutique science. Today, in contrast, elementary astronomy classes regularly expose students to the topic of black holes and the fact that they may be responsible for as much as one half of the radiative energy in the nonthermal universe. Black holes are real; nature exploits them to construct particle accelerators. Powered by gravity, shocks in the relativistic particle flows in the vicinity of neutron stars and black holes may transform a fraction of the energy into the acceleration of particles, mostly protons. We do not know how, or even where, this happens, but we have detected cosmic rays with Joule energy that bear witness to the enigmatic processes that pack a macroscopic energy into a single elementary particle.

Enter cosmic neutrinos. With IceCube's discovery that they actually exist, cosmic neutrinos reveal an unobstructed view of the universe at wavelengths where the universe is opaque to light. With more than one thousand times the energy of the highest energy neutrinos produced with earthbound accelerators, cosmic neutrinos also exceed by a factor of one billion the energy of the neutrinos detected from a supernova that exploded in the Large Magellanic Cloud in February 1987, the only neutrinos that have reached us from outside the solar system prior to IceCube's breakthrough. It is therefore probably somewhat counterintuitive that the more surprising property of the observed cosmic neutrinos is not their energy but their large flux.

An immediate inference made about the large neutrino flux observed by IceCube, which is predominantly extragalactic in origin, is that the total energy density of neutrinos in the high-energy universe is similar to that of gamma rays. This is worthy of a closer look. Neutrinos are the decay products of pions. Protons accelerated in regions of high magnetic fields near neutron stars or black holes may interact with the radiation or dust surrounding them to produce pions and kaons that decay into neutrinos. This is how neutrino beams are produced at Fermilab, where the target material is arranged to be sufficiently dense so as to absorb all secondary particles created in the collisions, except the neutrinos of course. Not so in the sky, where pions and kaons are produced in more tenuous radiation fields or in dust in the vicinity of the accelerator. Elementary particle physics dictates that neutral pions, which promptly decay into two gamma rays, inevitably accompany charged pions generating neutrinos. No gamma ray has ever been observed matching the 10 to 10,000 TeV energy range of IceCube neutrinos.

This turns out not to be a problem, and its solution is revealing. The universe is not transparent to high-energy photons: unlike neutrinos, these interact with microwave photons before reaching Earth. The resulting electromagnetic shower subdivides the initial photon energy, resulting in multiple photons in the GeV-TeV energy range by the time the shower reaches Earth. The calculation is straightforward, and it is intriguing that this photon flux accompanying IceCube's neutrinos provides an excellent match to the extragalactic gamma-ray flux observed by the Fermi satellite, as can be seen from the figure below.



The figure shows that the astrophysical neutrino flux (black line) observed by IceCube matches the corresponding cascaded gamma-ray flux (red line) observed by Fermi. The black data points are combined IceCube results, showing the flux of cosmic neutrinos interacting inside the detector. Also shown shaded in blue is the best fit to the flux of cosmic muon neutrinos penetrating the Earth.

The matching energy densities of the extragalactic gamma-ray flux detected by Fermi and the high-energy neutrino flux measured by IceCube suggest that they originated in common sources. Rather that detecting some exotic sources, it looks more likely that IceCube observes the same universe as astronomers do. The finding implies that a large fraction, possibly most, of the energy in the nonthermal universe originates in hadronic processes, indicating a larger level than previously thought. We are developing methods, including real-time multiwavelength observations with astronomical telescopes, to identify the sources and build on the discovery of cosmic neutrinos to launch a new era in astronomy.

Neutrino astronomy challenges our present understanding of the extreme universe and should be a key component of the new initiative in multimessenger astrophysics recently prioritized by the NSF. We have proposed as a next step the extraordinary opportunity of instrumenting 10 km3 of glacial ice at the South Pole and thereby improving on IceCube's sensitive volume by an order of magnitude. Importantly, this large gain is made possible by the unique optical properties of the Antarctic glacier revealed by the construction and operation of IceCube. Extremely long photon absorption lengths in the deep Antarctic ice means the spacing between strings of light sensors may exceed 250 meters, enabling the instrumented volume to grow rapidly while the construction cost remains comparable to that of the current IceCube detector. The new facility would have the goal of increasing the event rates from hundreds to thousands over several years.

NASA Centennial Challenge 2016: Mars Ascent Vehicle

By Robert S. Williamson III (Ph.D., Atomic Physics, 1997, UW-Madison)

The National Aeronautics and Space Administration (NASA) started seeking solutions to some of their biggest advanced technology problems by opening them to the public in 2005 through the Centennial Challenge program. This program seeks solutions that involve rocketry, robotics, small satellites, and even tissue engineering. Each program issues detailed specifications and requirements via public solicitation, then has a competitive down-selection. Once selected, each team receives NASA oversight through the development process, then culminates in a judged contest among the competitors. Ultimately, a monetary prize is awarded to the top three solutions that meet the requirement.

The Mars Ascent Vehicle (MAV) Centennial Challenge seeks a system capable of capturing a soil sample payload, loading it into a rocket, securing the payload, sealing the rocket, and erecting the rocket for launch, simulating a sample return mission from the surface of Mars. The system must be fully autonomous, and must meet specific design goals including overall size, mass, and speed to complete the task. Furthermore, the rocket must be launched at a precise angle and meet an altitude target of one mile.

Historically, the competing teams have been comprised primarily of college- and university-level students with several dozen members per team. In the fall of 2015, NASA opened the program to allow "non-academic" teams to submit proposals, enabling the Madison West Rocket Club to participate in the second season of the Centennial MAV program.

The club, composed entirely of students from Madison West High School, has been participating in NASA-sponsored rocketry challenges for over a decade, with the goal of giving students real-world experience designing and solving science and engineering challenges that employ small sounding rockets and payloads. The club has worked with many professors and students at the University of Wisconsin physics department including Prof. Dan McCammon, Prof. Mike Winokur, Prof. Baha Balantekin, Prof. John Sarff, Mike Randall, Dr. Mike Westphall, Don Michalski, and Dr. James Lattis. Staff from many other departments at UW-Madison, and most recently the Gilroy Botany Laboratory, have provided support over the years as well, advising science payload developments, aiding in the analysis of experimental results, and providing teleconference capability and meeting spaces.

The team competing for the MAV program was comprised of ten West High School students, all juniors and seniors, led by mentor Rob Williamson (Ph.D. 1997, Physics, UW-Madison), with support from Joe Shoneman, Jim Guither, and Brent Lillesand.

The Madison West Rocket Club is entirely self-funded, primarily through autumn leaf-raking and donations, giving students the additional ownership and appreciation for the challenges of fund-raising, as well as emphasizing the importancet of developing a solution within a defined fiscal budget. The club was co-founded 13 years ago by Christine Hager (B.S. 1991, Bacteriology, UW-Madison), a science teacher at West, along with Thomas P. Hanzlik, a West High School student.

The MAV Centennial Challenge, working with NASA's long-standing Student Launch (NASA SL) program, guides teams through NASA's structured project development cycle for payload and solution development, with strong emphasis on design and flight readiness reviews, safety evaluation, documentation, and prototyping. This occurs over the course of eight months, starting from statement of work submission in September and progressing through to flight readiness review in April. The NASA SL development program is punctuated by several video teleconferences at key design milestones, giving students the opportunity to both present their work and be challenged by seasoned NASA engineering staff.

An important key element of the NASA SL program is that all students provide educational outreach and enrichment to local elementary and secondary schools. The team accomplishes this through local science festivals and related events by using educational displays and hands-on demonstrations, all designed and built by team members.

Given a short timeframe, limited budget, and a small team of already heavily-scheduled high school students, the team focused upon a solution that met all of NASA's requirements yet had no other non-essential features. This led to choosing a rocket design that was of the minimum size necessary to accomplish the mission (less than 5 feet long), and building a robot that used as many off-the-shelf components as possible, including passive, spring-loaded elements rather than motors wherever possible. The team analyzed their designs in detail, requiring them to rapidly upgrade their knowledge of physics to solve real-world problems including torque balance analysis, materials strength evaluation, and even fin-flutter aerodynamic calculations. They utilized engineering skills to implement a working robot/rocket system. Their management skills were challenged to ensure they met the strict deadlines imposed by NASA as well as budgeting time for extensive testing of the system both at the club workshop and once it arrived at the competition site in Huntsville, Alabama. They learned to work closely together as a team and to challenge each other's ideas in an open, creative, focused, and goal-driven environment.

Top view of completed Automated Ground Support Equipment (AGSE) with sample return rocket Mars Ascent Vehicle (MAV). This winning design weighed only 86 pounds and had a volume of less than 9 by 2.5 by 1.5 feet overall, and accomplished the task of loading and securing the payload and erecting the rocket for launch in less than 55 seconds.

Madison West was the first and only high school to ever win any of the NASA Centennial Challenges, and was among 19 teams competing in the MAV competition this year. The robot they designed and built was also the lightest and simplest design among all of the teams, a single-piece design visible in the foreground of the photo above. One NASA official judging the solutions commented "wow, you guys really nailed this one!" Another official mistook our rocket for a half-scale prototype, surprised that we could accomplish the goal with such a compact rocket design.

The Madison West team's autonomous robot and rocket met all of the NASA requirements for overall mass (86 pounds of 150 allowed), speed of task completion (53 seconds of 600 seconds allowed), and met the 1-mile altitude target within 4.3%. Ultimately, the team won second place among the 19 teams, winning a cash prize. They were bested only by Cornell University's team who had several dozen undergraduate and graduate students!

The club now continues in its 14th year, continuing to provide students real-world STEM experience. Currently, student teams are working on a variety of exciting projects. One is collaborating with the UW-Madison botany department, with some summer students recently presenting at the local chapter of the Astrobotanical Society, developing plant payloads that will potentially end up on the International Space Station. Another group is developing a plasma-based thrust engine with the UW-Madison engineering department, supported by the National Science Foundation and destined to be an educational display for the club's many outreach programs. The senior Student Launch 2017 team just started developing an autonomous paraglider-based sounding rocket recovery system guided by GPS, live land imaging via embedded camera, and gyro/accelerometers, with the goal of supporting interplanetary sample return missions.

http://isthmus.com/news/news/rocketry-club-madison-west-high-nasa/
http://martians.westrocketry.com/
http://www.nasa.gov/directorates/spacetech/centennial_challenges/index.html

2016 Physics Awards Banquet

The 2016 Physics Banquet & Awards Ceremony to honor the Department Award Recipients and Alumni Fellows was held on Friday, May 6, 2016 at the Fluno Center. We honored our award winners with a reception, dinner, and awards ceremony for the family and friends.

Undergraduate Awards

Fay Ajzenberg-Selove Award

No photo available

Leah Fulmer

This award is presented to undergraduate women majoring in Physics, Astronomy, or Physics/Astronomy to encourage them to continue their careers in science. Dr. Ajzenberg-Selove, who received her Ph.D. in Physics in 1952, was a Professor Emeritus at University of Pennsylvania.

Dr. Maritza Irene Stapanian Crabtree Award

Rachel Gruenke and Benjamin Hoscheit

This fund was established by William Crabtree to honor his wife, Dr. Maritza Crabtree, who graduated with a Physics degree in 1971. This annual award benefits undergraduate students in physics based equally on merit and need.

Bernice Durand Undergraduate Research Scholarship

Maggie Beheler-Amass

This award was established by Emerita Physics Professor Bernice Durand to promote meaningful undergraduate research and to support and encourage women and ethnic minorities as undergraduate majors in Physics and Astronomy.

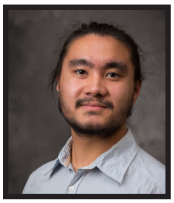
L. R. Ingersoll Prize

Spring 2014–2015: Siddak Kanwar (103) | Brent Janssen (104) | Daniel Kurniawan (201) | Sherkhan Sauyrtayev (202) | Brett Paris (202) | Samantha Miller (207) | William Ferris (241) | Tom Stone (248)

Fall 2015–2016: Hao Yu (103) | Wei He (201) | Rachel Maguire (202) | Thomas Gu (207) | Colin Grosh (241) | Roger Waleffe (247) | Kevin Langhoff (249)

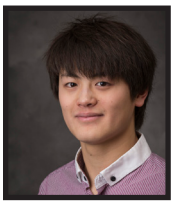
This prize is given for distinguished achievement in introductory physics. It is underwritten by a fund established by the family and friends of the late Professor Ingersoll, a distinguished physicist and teacher at the University who served as Department Chair for many years.


Siddak Kanwar

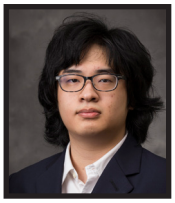

Sherkhan Sauyrtayev


Brett Paris


Samantha Miller


Hao Yu

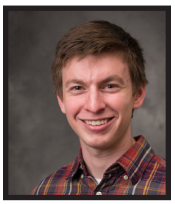

Rachel Maguire


Thomas Gu


Roger Waleffe


Kevin Langhoff

Liebenberg Family Research Scholarship



Colin Adams

This scholarship is awarded is for Physics, AMEP, or Astronomy/Physics majors. This scholarship opportunity was initiated by the Liebenberg family for the purpose of promoting undergraduate summer research opportunities.

Albert Augustus Radtke Scholarship Award

Eli Mueller

This scholarship is is given to outstanding junior or senior students majoring in Physics or Applied Mathematics Engineering and Physics. This award was made possible by a bequest of the late Mrs. Elizabeth S. Radtke in honor of her husband, a 1900 degree recipient from UW-Madison.

2016 Physics Awards Banquet

Graduate Awards

Henry & Eleanor Firminhac Scholarship Award

Emily Lichko

The Fund was established by former UW graduate, the late Ralph Firminhac (BS '41, MS '42). He created this scholarship in memory of his parents, Henry & Eleanor Firminhac.

Joseph R. Dillinger Award for Teaching Excellence

Andrew Loveridge

This Award for Teaching Excellence was made possible by the family of Joseph Dillinger in honor of their father. The award provides recognition to an outstanding teaching assistant in undergraduate-level Physics. Prof. Dillinger was a faculty member of the department with a special interest in improving undergraduate education.

Charles Elwood Mendenhall Award

Matthew Beck

This award was made possible through the generosity of the Charles Elwood Mendenhall estate. Mendenhall received his Ph.D. from Johns Hopkins in 1898. He was a faculty member in the Department of Physics from 1901 until his passing in 1935.

Allan M. and Arline B. Paul Physics Award

Usama Hussain

The late Mrs. Arline Borer Paul (1914-2012) created this endowment fund, for graduate scholarships in memory of Walter Max Borer. Walter was Arline's brother and received an MS degree in 1937

Emanuel R. Piore Award

Edward Basso (Fall 2015)

Deepak Mallubhotla (Spring 2016)

The award is made possible through the generosity of the Piore family. It is awarded to the graduate student with the highest score on the qualifier examination.

Van Vleck Award

Leon Maurer

This Award is used to support graduate students in physics.

Department TA Awards

Best Teaching Assistant

Leon Maurer

Alex Loving

Leon Maurer (Spring 2015)

Alex Loving (Fall 2015)

Rookie of the Year

No photo available

Alex Scherer

Alumni Awards

Distinguished Alumni, Distinguished Scientist, & Distinguished Service Awards

Howie Baer

Siu Au Lee

Howie Baer

Siu Au Lee

Stephan Meyer

Marv Ebel

Stephan Meyer

Marv Ebel

UW Physics Degrees Awarded

Undergraduate Degrees

FALL 2015

Bohling, Brandon
Christenson, Anna
Frickelton, Michael
Wu, Tianyao
You, Tae Yang

SPRING 2016

Alt, Erich
Becerra, Juan
Boyd, Joseph
Briesemeister, Zackery
Carr, David
Cianciara, Aleksander
Dickinson, Joseph
Feigenson, Thomas
Greene, Sean
Hawley, Cory
Henckel, Anna
Heup, Jenni
Jaeger, Austin
Kay, Ethan
Keal, Ellen
Khan, Asif
LaJeunesse, Janelle
Martens, Kylee
McInturff, Zane
Nestingen-Palm, David
Peaslee, Samuel
Shahrani, Zane
Sun, Linke
Wahl, Colin
Witt, Jenny
Xie, Chengkun
Xu, Yongchen
Young, Chris

SUMMER 2016

Butzen, Daniel
Orchard, Alexander
Stevenson, Corey
Sukumar, Kevinraj

Master Degrees

FALL 2015

Davoody, Amirhossein | Advisor: Knezevic | Award: Master of Arts
Leonard, Edward | Advisor: McDermott | Award: Master of Science

SPRING 2016

Hussain, Usama | Advisor: Smith | Award: Master of Arts
Olson, Joseph | Advisor: Egedal | Award: Master of Science
Sebald, James | Advisor: Halzen | Award: Master of Arts
VanMeter, Patrick | Advisor: Sarff | Award: Master of Arts

SUMMER 2016

Cook, Cole John | Advisor: McCammon | Award: Master of Arts
Li, Jiande | Award: Master of Arts

Doctoral Degrees

FALL 2015

Arguelles Delgado, Carlos | Advisor: Halzen | Thesis:New physics with atmospheric neutrinos | Employment: Post-doc at MIT LNS

Belknap, D. Austin | Advisor: Smith | Thesis: Spin and parity of the Higgs boson near mH =126 GeV/c2 in the H--> ZZ-->4l channel and a search for a doubly charged Higgs with the CMS detector at the LHC | Employment:

Korver, Anna | Advisor: Walker | Thesis: Towards and NMR oscillator | Employment:

McNally, Frank | Advisor: Westerhoff | Thesis: Systematic studies of cosmic-ray anisotropy and energy spectrum with IceCube and IceTop | Employment: Visiting Assistant Professor at Carleton College

Sauppe, Joshua | Advisor: Sovinec | Thesis:Extended magnetohydrodynamic modeling of plasma relaxation dynamics in the reversed-field pinch | Employment: Los Alamos National Lab

SPRING 2016

Hostetter, James | Advisor: Saffman | Thesis: Laser cooling, trapping, and Rydberg spectroscopy of neutral holmium atoms | Employment: Research Scientist at Honeywell

Ming, Yao | Advisor: Wu | Thesis: Search for bb decay of the Stand Model Higgs boson produced in association with a vector boson (W/Z) with the ATLAS detector | Employment: Software engineer at Amazon

Ribeill, Guilhem | Advisor: McDermott | Thesis: Qubit readout with the Josephson Photomultiplier | Employment: Scientist at Raytheon BBN Technologies

SUMMER 2016

Wisher, Ian | Advisor: Westerhoff | Thesis: Real-time transient monitoring with the HAWC detector: design and performance | Employment: Grainger Fellow at University of Chicago

Maurer, Leon | Advisor: Knezevic | Thesis: Phonon dynamics and thermal transport in surface-disordered nanostructures | Employment: Associate at McKinsey & Company

Crow, Daniel | Advisor: Joynt | Thesis: Topics in quantum computation and information: entanglement noise and error correction | Employment:

Garon, Todd | Advisor: Everett | Thesis: Topics in the phenomenology of two non-minimal models of supersymmetry breaking | Employment: Data Scientist

Levine, Aaron | Advisor: Dasu | Thesis: A search for lepton flavor violating decays of the Higgs boson and a measurement of W boson production using the CMS detector at the LHC | Employment: Post-doc at UW-Madison

Perry, Thomas | Advisor: Smith | Thesis: A measurement of Wbb production and a search for monophoton signals of dark matter using the CMS detector at the CERN LHC | Employment: Post-doc UW-Madison

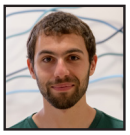
Weisberg, David | Advisor: Forest | Thesis: Pursuing the plasma dynamo and MRI in the laboratory : hydrodynamic studies of unmagnetized plasmas at large magnetic Reynolds number | Employment: Post-doc at General Atomics

Morton, Lucas | Advisor: Den Hartog | Thesis: Turbulence and transport in magnetic islands in MST and DIII-D | Employment: Post-doc at Princeton Plasma Physics Laboratory

2016 Fall Admissions

Conjeepuram V. Ambarish
Indian Institute of Technology Delhi
Joynt - Quantum Computing

Joelle Baer
Hamilton College
Eriksson - Condensed Matter/Solid State

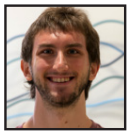


Aaron Batker Pritzker
Harvey Mudd College
Friesen - Condensed Matter/Solid State

Wyatt Behn
U. of Nebraska -Kearney
Yavuz - Condensed Matter/Solid State

Gage Bonner
Queen's University at Kingston
Shiu - String Theory

Ian Broderick
University of Notre Dame
Palladino - Neutrino and Astroparticle

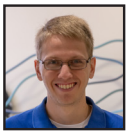


Michael Cervia
University of Chicago
Saffman - Quantum Computing

Ting Gu
Pennsylvania State Univ.
Wu - Particles/High Energy

Urvashi Gupta
Indian Inst of Science
Saffman - Quantum Computing

Harry Hausner
Union College
Everett - Particles/High Energy

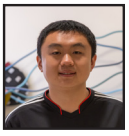


Evan Heintz
Otterbein College
Everett - Astrophysics

Gregory Holdman
Whitman College
Bai - Undecided

Raamis Hussain
UC Santa Barbara
Westerhoff - Particles/High Energy

Joseph Jepson
Utah State University
Hegna - Plasma



Xiaoyu Jiang
Peking University
Yavuz - Atomic/Molecular/Optical

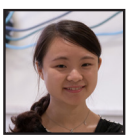
Taweesak Jitsuk
Mahidol University
Sarff - Plasma

Rishabh Khandelwal
Indian Institute of Technology Bombay
Karle - Neutrino and Astroparticle

Bradley Kumm
Univ Of Michigan At Dearborn
Vandenbroucke - Neutrino and Astroparticle

Ping-Yu Li
National Taiwan Univ.
Boldyrev - Plasma

ChuanHong Liu
XiAn Jiaotong University
McDermott - Atomic/Molecular/Optical



QinRui Liu
Wuhan University
Gilbert - Undecided

Andrew Loeliger
U. of Colorado Boulder
Smith - Particles/High Energy

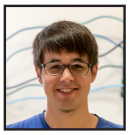
Wilson Lough
Northern Arizona Univ.
Shiu - Particles/High Energy

William Luszczak
UC Santa Barbara
Karle - Neutrino and Astroparticle

Jithin Madhusudanan Sreekala
National Institute of Technology Calicut
Dasu - Particles/High Energy

Naveen
Indian Institute of Technology Roorkee
McDermott - Condensed Matter/Solid State

K. Cole Newton
Reed College
Balantekin - Particles/High Energy



Jonathan Nikoleyczik
Penn State Univ.
Carlsmith - Neutrino and Astroparticle

Ariel Rock
Swarthmore College
Boldyrev - Plasma

Avirup Roy
Indian Inst of Science Ed & Res
Eriksson - Quantum Computing

Joel Siegel
University of Chicago
Brar - Condensed Matter/Solid State

no photo available

Manuel Silva
UC Berkeley
Wu - Particles/High Energy

Cayla Stifler
Providence College
Walker - Atomic/Molecular/Optical

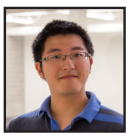
Leslie Taylor
UC Berkeley
Walker - Atomic/Molecular/Optical

Stephen Trembath-Reichert
U. of Michigan-Ann Arbor Walker - Atomic/Molecular/Optical

no photo available

Sidney Vetens
Reed College
Everett - String Theory

Megan Wachtendonk
Univ. of Washington
Karle - Neutrino and Astroparticle



Alex Wang
UC Berkeley
Chung - Phenomenology

Christopher Young
UW-Madison
Westerhoff - Astrophysics

Support Physics via the UW Foundation

Undergraduate

132691618. Fay Ajzenberg-Selove Undergraduate Scholarship provides encouragement for undergraduate women majoring in Physics, Astronomy or Physics-Astronomy to continue their careers in science.

132693412. Dr. Maritza Irene Stapanian Crabtree Undergraduate Scholarship provides assistance to undergraduate students based on merit and need.

132693561. Bernice Durand Research Scholarship promotes meaningful undergraduate research opportunities, plus supports and encourages women and ethnic minorities as undergraduate majors in the Departments of Physics and Astronomy.

132693645. Henry & Eleanor Firminhac Scholarship provides assistance to students in Physics with financial need. (Undergraduate or Graduate)

132692683. Liebenberg Family Research Scholarship supports Physics, AMEP or Astronomy-Physics majors in summer research experiences.

132697989. Hagengruber Fund provides assistance to undergraduate physics students who are Wisconsin residents with financial need; and who show exceptional promise for a future in physics or a related field.

112697824. Physics Board of Visitors Undergraduate Research Fund provides funding for awards that will assist directed study projects in pure and applied physics; multidisciplinary projects linking physics to such fields as biology; engineering; business; and creative expression; and participation in related conferences.

Graduate

132697960. Allan M. and Arline B. Paul Physics Fund provides support to graduate students in memory of Walter Max Borer (MS 1937).

132697988. Carl and Brynn Anderson Graduate Physics Fund provides support for graduate student recruitment and retention, travel for study and research, materials for study or research; recognizing achievement in scholarship.

132697201. Casey M. Durandet Graduate Fund provides support, in memory of Albert R. Erwin, Jr., to graduate students working in experimental high energy physics.

132692082. Cornelius P. & Cynthia C. Browne Endowed Fellowship Fund provides support to graduate students pursuing doctoral studies in the Physics Department.

132693190. Elizabeth S. Hirschfelder Endowment supports women graduate students in Physics research.

132691960. Jeff & Lily Chen Wisconsin Distinguished Graduate Fellowship provides a full year fellowship to an outstanding graduate student in the department.

132691359. Joseph R. Dillinger Teaching Award Fund provides recognition to an outstanding teaching assistant in the Department of Physics.

132693916. Karl & Alice Knapp Jansky Fellowship Fund provides alternate year funding to an outstanding graduate student in Physics and Astronomy.

132696175. Phyllis Jane Fleming Graduate Student Support Fund provides support for a female doctoral candidate in any year of training in physics.

112698294. Physics Alumni Graduate Award Fund provides support to incoming graduate students who hold Teaching Assistant appointments in the department.

132695150. E. R. Piore Award provides support to the recipients of the highest qualifying exam scores each semester.

132692106. Graduate Student Recruiting provides assistance in recruitment expenses of Physics graduate students.

132691808 and 132692368. Ray & Anne Herb Wisconsin Distinguished Graduate Fellowships provides a full year fellowship to one or two outstanding graduate students engaged in materials research in the department.

132697430. Robertson Leach Graduate Student Fund provides support for incoming, first year graduate students in the department.

112696443. L. Wilmer Anderson & Dave Huber Graduate Support Fund provides a number of awards to new graduate students entering the department. This award is in honor of Profs. L. Wilmer Anderson and David Huber.

132695370. Van Vleck Fellowship Fund in Physics provides support to graduate students in the department.

Research

132694421. Barschall Enterprise Fund was established in 2005 in honor of former Professor Heinz Barschall. Provides unrestricted-use fund for Chair in recruiting senior researchers to faculty.

132906418. David Grainger Physics Library Fund provides funding for the acquisition of books and other materials related to physics.

132694069. Friends of the Physics L. R. Ingersoll Museum provides funding for museum display upgrades and student docents.

112694622. Physics Community-Building Fund provides funding for Chair in establishing and reaffirming a sense of community among the faculty, staff, students, and alumni of the Department.

112698078. Wonders of Physics Outreach Fund provides support for the continuation of the Wonders of Physics annual shows as well as the grade school show program.

132692106. Atomic Collision Research Fund encourages and supports research on atomic collision processes and their application to studies of weakly ionized gases in perpetuity.

112691418. Elementary Particle Physics Institute provides funding for activities of the institute.

132690387. L. R. Ingersoll Fund provides support for colloquia and seminars in the department.

132691720. Physics Newton Fund is a general, unrestricted fund administered by the Department Chair. The purpose of this fund is to aid the Department of Physics in its research, teaching and public service roles.

132697999. Quantum Computing Research Center Fund provides support for research in quantum computing in the physics department.

112696250. Thomas G. Rosenmeyer Cosmology Fund provides support for the Prof. Peter Timbie research group in its teaching, research, and public service roles.

Support Physics

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☐ My gift of $ _____, payable to the University of Wisconsin Foundation, is enclosed.

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For a description of all UW Foundation Physics Funds, go to:http://www.physics.wisc.edu/donate/funds

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I wish to designate my Gift to the following fund(s)

☐ Physics Newton Fund (#1269172)—An unrestricted general fund—greatest need.

☐ Undergraduate Support—General (#1269172)
To provide for undergraduate student special needs.

☐ Undergraduate Support—Specific
Indicate fund name and number below.
Select from list of "undergraduate" funds on previous page.
Fund Name: _____ Fund Number: _____

☐ Graduate Support—General (#1269172)
To provide for graduate student special needs.

☐ Graduate Support—Specific
Indicate fund name and number below.
Select from list of "graduate" funds on previous page.
Fund Name: _____ Fund Number: _____

☐ Research
Indicate fund name and number below. Select from list of "Research" funds on previous page.

Fund Name: _____ Fund Number: _____

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

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University of Wisconsin Department of Physics