



DEPARTMENT OF

WINTER 2019-20

Physics & Astronomy

MSU College of Natural Science | Newsletter for Alumni and Friends

MSU-Q:

A calculated leap into quantum computing

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This background image depicts a quantum interference measurement performed on a superconducting qubit system in the labs at MSU-Q.

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From the Department Chair...

Putting together this newsletter is one of the new jobs for me as department chair. Fortunately, it is one of the easier items on my “to-do” list because there are many accomplishments to celebrate.

I’ll start with one of my favorite topics—our students. Our incoming graduate and undergraduate classes this year were our largest ever. We have 43 first-year graduate students, with a record three NSF Graduate Research Fellowship Program awardees and a record number of college and university fellowships. We had more than 100 incoming freshmen declare their intention to major in physics or astronomy—part of a steadily increasing trend. It is gratifying that so many talented students have chosen to study with us.

In the area of new faculty, the two most recent arrivals are noted on page 4 of this newsletter. We also have three faculty searches happening this year and hope for several more in the coming year. These new positions will enable us to continue to build on our strengths and remain in the forefront of physics and astronomy for decades to come. For example, across the subdisciplines in the department, we are actively working on “big data.” This includes astronomy and astrophysics and particle physics, where we have a very successful machine learning seminar series, among others. Physics faculty members are also playing lead roles in the recently announced cross-campus “quantum initiative” (see article on page 6).

Embedded within our faculty hiring is a deep commitment to equity and inclusion at every level of the department. I have long felt that faculty hiring is the most important thing for a department to do well

to grow in the future. Our success in hiring over the years shows up in the accomplishments of our early-career faculty members. They have all been highly successful in establishing their research programs, obtaining grants and making exciting discoveries in physics and astronomy. These science successes then get reflected in other ways that universities track—for example, our research grants have been up significantly year upon year even given the flat federal funding environment.

Great faculty and students need effective infrastructure to reach their full potential. Fortunately, we have many

excellent resources. The new STEM Teaching and Learning Facility going up near Spartan Stadium will open opportunities for innovative ways to deliver our large introductory physics courses and labs when it is completed in 2021. The BPS building continues to serve us well—a testament to the wisdom and foresight of the senior members of the department who put great effort in, decades ago, to ensure this would be the case.

We are continuously updating our facilities to stay at the forefront of our work. In moving forward in these areas, we have

benefitted from good working relationships with the administrative offices on campus. At the same time, we particularly benefit from donors. Donor support enables us to do things that we simply couldn’t do otherwise.

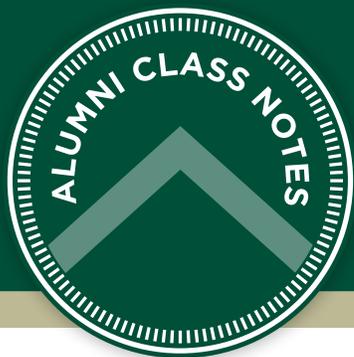
I’d like to close this message by acknowledging the department staff. The transition from a regular faculty member to the chair of a large department is not a small one and has been made immensely smoother by the kind, patient and extraordinarily capable staff of the department. 🍀

“Embedded within our faculty hiring is a deep commitment to equity and inclusion at every level of the department.”



Stephen Zepf, Chairperson
Department of Physics and Astronomy

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Henry Darlington, physics, '49, was a member of the Apollo spacecraft program between 1963 and 1968, where he worked on the North American Aviation/Rockwell Apollo Spacecraft project in their Test and Operations Department in Downey, Calif. Following the Apollo project, he applied similar technology to remote monitoring and control requirements for centralized monitoring and control of large electric utility transmission and generation systems for the next 25 years, consulting throughout the United States, Canada, Brazil, Columbia and Australia.

Howard Stears, physics, '65, originally from Wyandotte, Mich., served in the Air Force for 20 years and retired as a lieutenant colonel. During his years in the Air Force, he was stationed at the McClellan Air Force Base near Sacramento, Calif., where he worked on Project Blue Book, helped on a computer update for the EC121 and assisted with other engineering tasks including a missile system out on Johnston Island. He was then moved to Wright Patterson AFB in Dayton, Ohio.

Karl Blasius, astrophysics, '69, has, over the past five years, transitioned from intensive study of studio art (sculpture and painting) to biology and psychology. He teaches his own classes on the biology of aging at a

local community college and gives periodic guest lectures in other classes on how best to maintain health while aging.

John Zwart, M.S., physics, '79; Ph.D., physics, '85, is Professor Emeritus of physics, retiring after serving 36 years at Dordt University in Sioux Center, Iowa.

J. Erik Hendrickson, M.S., physics, '90; Ph.D., physics '94, is chair of the Physics and Astronomy Department at the University of Wisconsin – Eau Claire (UWEC). He previously chaired the department from 2002 to 2011. Hendrickson joined UWEC in 1994.

Michael Davis, M.S., astrophysics and astronomy, '99; Ph.D., astrophysics and astronomy, '02, was recently promoted to staff scientist and named section manager of the Astrophysics and Remote Sensing Section of the Space Science and Engineering Division at Southwest Research Institute, San Antonio, Texas.

Joseph Kozminski, M.S., physics, '01; Ph.D., physics, '05, was elected to a four-year term on the Naperville (Illinois) Community Unit School District 203 Board of Education in April 2019.

Amanda Jo Bayless, astrophysics, '02, was awarded the *San Antonio Business Journal's* 40 under 40 award.

Ramon Barthelemy, astrophysics, '10, recently accepted a position as an assistant professor of physics and astronomy at the University of Utah in Salt Lake City. Prior to joining the university, he completed a Fulbright Scholarship in Finland, a AAAS Science Policy Fellowship, and spent three years in the private sector.

Nathan Wasylewski, physics, '13, is a mechanical engineer at the Lear Corporation.

Stephanie Hamilton, physics, '14, successfully defended her Ph.D. in physics from the University of Michigan this year. Her thesis research used a large, international astronomy project called the Dark Energy Survey to study the outermost region of our solar system, the Kuiper Belt. Hamilton is now transitioning to a career in science communication and hopes to continue spreading new knowledge about this beautiful universe for a long time to come.

Meg Davis, astrophysics, '19, was recently hired as a post-baccalaureate researcher for the next year in the physics and astronomy department at Michigan State University, where she is researching compact objects in binary systems via x-ray and also helping run the MSU Observatory's outreach as one of its public outreach coordinators.

New Faculty



Hayden

Daniel Hayden became an assistant professor in August, having joined the MSU Department of Physics and Astronomy in April 2013 as a postdoctoral research associate with the High Energy Physics experimental group. Based at CERN, Hayden worked on ATLAS detector experiments. He received his Ph.D. from Royal Holloway,

University of London, in 2012. Hayden's research interests include examining physics beyond the standard model to solve unexplained phenomena; searching for new theoretical particles, such as the graviton, using the ATLAS Detector at CERN; and understanding why gravity is so weak.



Kerzendorf

Wolfgang Kerzendorf, assistant professor, joined MSU in fall 2019 as part of the astronomy group with a joint appointment in the Department of Computational Mathematics, Science and Engineering. He completed his doctoral research at the Australian National University in 2011, with a thesis titled "Type Ia Supernovae: Progenitors and

Explosions," under Nobel laureate, Brian Schmidt, who discovered dark energy. He then worked as a postdoctoral research fellow at the University of Toronto before joining the European Southern Observatory as an astronomer in late 2014. Kerzendorf is the lead developer of the widely used TARDIS code to model radiation transport. His research interests are in stellar explosions and machine learning.

In Memoriam



Loh

Edwin Loh, professor, died June 7, 2019, at age 71. Born in Suzhou, China, Loh immigrated to the United States at just a few months old, earned his Ph.D. from Princeton University and joined MSU in 1987. An influential and admired educator at MSU for 31 years, Loh taught thousands of students. His astronomy-focused research was aimed at

building innovative instrumentation for telescopes, including the Spartan infrared camera for the SOAR telescope in Chile. This instrument was one of his major achievements and played a significant role in the success of the SOAR telescope consortium as well as MSU's astronomy program.



Pumplin

Jon Pumplin, faculty member from 1970 to 2018, died on Nov. 22, 2019, at age 76. Jon received his B.S. and Ph.D. degrees in theoretical physics from the University of Michigan. After graduating in 1968, he spent two years as a research associate at the Stanford Linear Accelerator Laboratory before joining the MSU Department of Physics in 1970.

Pumplin was a recognized leader for his work on parton distribution functions, which describe the substructure of protons and neutrons. Obtaining these functions is an elaborate procedure carried out by a collaboration known as CTEQ. Pumplin's work enabled CTEQ to provide virtually every accelerator experiment with the means to rigorously analyze its data and compare theory with experimental results, which led to a remarkably high citation rate for the CTEQ publications.

Retirements



Bromberg

Carl Bromberg will retire from the department on Dec. 31, 2019, as a professor emeritus. Bromberg received his Ph.D. in 1974 from the University of Rochester, New York, and joined the MSU faculty in 1979. His research focused on construction and analysis of several High Energy Physics experiments at Fermilab. Most recently, Bromberg participated in the design and construction of the NOvA neutrino oscillation experiment and is now a visiting professor at Brookhaven National Laboratory where he will continue his neutrino research.

Scott Bogner, professor, was named a 2018 American Physical Society Fellow for the development and application of renormalization group methods to low-energy nuclear physics. He was nominated by the Division of Nuclear Physics.

Remco Zegers, professor, was elected an American Association for the Advancement of Science Fellow last November for distinguished contributions to the fields of nuclear science and nuclear astrophysics, particularly for the determination of weak interaction rates inferred from heavy-ion collisions.

The European Physical Society awarded members of the **Collider Detector at Fermilab (CDF)** and **DZero** collaborations with the Europhysics 2019 prize “for the discovery of the top quark and the detailed measurement of its properties.” The CDF and DZero is composed of hundreds of scientists from around the world, including MSU. The prize is given every two years to outstanding contributions to high-energy particle physics by people or collaborations.

Witek Nazarewicz, Hannah Distinguished Professor of Nuclear Physics and FRIB chief scientist, received an Honorary Degree from the University of York in the United Kingdom. Nazarewicz’s research aims to theoretically describe exotic, short-lived nuclei that inhabit remote regions of the nuclear landscape by utilizing nuclear physics, many-body systems and HP computing.

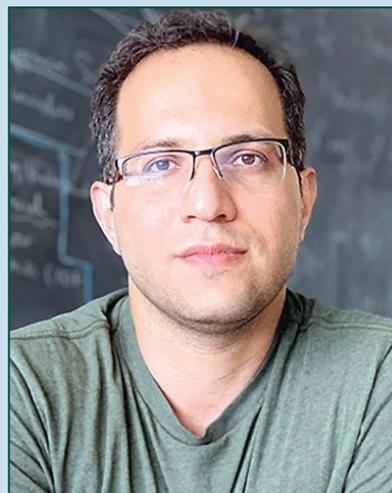
Mark Dykman, professor, was a Moore Distinguished Scholar at Caltech during the spring of 2019. The program was established to invite researchers of exceptional quality and national and international renown to Caltech for six months to enhance research.

Megan Donahue, professor, was named a 2019 University Distinguished Professor in honor of her achievements in research, teaching and mentoring, and community engagement. Donahue is an expert in clusters of galaxies, cosmology and galaxy evolution.

Marc Conlin, personnel manager, received a 2018 Alumni Service Award at the NatSci Grand Awards Gala for his outstanding volunteer service to MSU. Recipients possess the highest standards of integrity and character to positively reflect and enhance the prestige of MSU.

Marcos Dantus, University Distinguished Professor and MSU Foundation Professor of chemistry and physics, received the 2019 Technology Transfer Award at the MSU Innovation Celebration for his work with ultrafast lasers—an innovation that has contributed to Nobel Prizes in chemistry and physics.

Maghrebi receives prestigious young investigator award



Maghrebi

Mohammed Maghrebi, assistant professor, received the highly competitive Air Force Office of Scientific Research (AFOSR) Young Investigator Research Program

award given to outstanding early-career scientists and engineers. His project, “Driven-dissipative Architectures: New Routes to Quantum Phases and Technologies,” will be funded up to \$150,000 a year for three years.

Maghrebi’s research interests include nonequilibrium many-body physics in driven and/or dissipative systems, entanglement in quantum many-body systems and fluctuation-induced phenomena and quantum Brownian motion.

Filomena Nunes, associate professor, received MSU’s 2018-19 William J. Beal Outstanding Faculty Award. Nunes is one of the world’s leading nuclear reaction theorists who studies rare isotopes to address such fundamental questions as the origin of visible matter in the universe.

Three faculty members were awarded 2019 NatSci Awards. They are: **Norman Birge**, NatSci Outstanding Faculty Award; **Paul Irving**, NatSci Excellence-in-Teaching Citation; and **Wolfgang Mittig**, NatSci Postdoctoral Mentoring Award.

Three faculty and three staff members were awarded 2018 NatSci Awards. They are: **Filomena Nunes**, NatSci Outstanding Faculty Award; **Laura Chomiuk**, NatSci Teacher-Scholar Award and Undergraduate Teaching Award; **Kelsey Funkhouser**, NatSci Excellence-in-Teaching Citation; **Richard Hallstein**, NatSci Distinguished Academic Staff Award; **Artemisia Spyrou**, NatSci Graduate Academic Advisor Award; and **Thomas Palazzolo**, NatSci Support Staff Award.

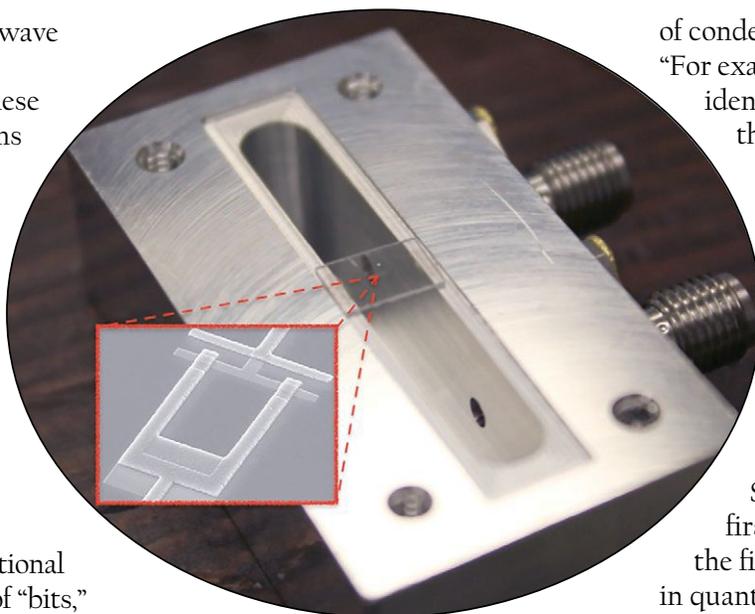
MSU-Q: A calculated leap into quantum computing

Noisy qubits. Microwave cavities. Nitrogen vacancy center. These may seem like terms straight out of a futuristic sci-fi novel but they are, in fact, part of the vocabulary of a quickly evolving field known as quantum computing.

Simply stated, quantum computing harnesses and exploits the laws of quantum mechanics to process information. A traditional computer uses long strings of “bits,” while a quantum computer uses quantum bits, or qubits. Unlike a bit, which can have only the value zero or one, a qubit can take on an infinite number of values. By using qubits instead of bits, quantum computers can make different, more powerful calculations.

As the world moves rapidly toward this quantum revolution, a team of Michigan State University scientists recently launched the MSU Center for Quantum Computing, Science and Engineering, or MSU-Q, to ensure that MSU continues to play a leadership role in this area. The center is directed by Angela Wilson and associate directors Andrew Christlieb and Johannes Pollanen.

“We’ve made so much progress with classical computers throughout the years, but we are quickly approaching the limit of what we can do with classical computing,” said Wilson, John A. Hannah Distinguished Professor of Computational Chemistry and adjunct professor of physics and astronomy. “The opportunity to build and grow quantum computing capacity at MSU is really going to open a lot of doors.”



Above is a photograph of a superconducting transmon qubit housed in a three-dimensional microwave cavity. The qubit exists on the chip located in the center of the cavity. The inset shows a zoomed-in view of the qubit.

The mission of MSU-Q is to bring together faculty from a variety of fields who are working toward the next generation of computers, communication and sensors based on quantum technologies. Currently, MSU-Q includes more than 20 faculty members spanning several departments—chemistry; physics; mathematics; computational, mathematics, science, and engineering (CMSE); electrical and computer engineering; and the Facility for Rare Isotope Beams, or FRIB.

“Quantum computing is amazing because, fundamentally, if we can build large-scale quantum computers, it will allow us to solve problems that aren’t currently answerable with the world’s best supercomputers,” said Pollanen, Jerry Cowen Chair of Experimental Physics and assistant professor

of condensed matter physics. “For example, there are already identified quantum problems that Summit—the world’s fastest supercomputer—can’t even come close to cracking.”

MSU has a rich history in quantum computing, which began some two decades ago with MSU’s Institute for Quantum Sciences, one of the very first institutes of its kind in the field. One of the key players in quantum computing at that time was MSU’s Mark Dykman, a theoretical condensed matter physicist.

“Mark was doing quantum computing before it was fashionable,” Wilson said. “He was truly a visionary in this area and was one of the first to understand how to control coupled multi-qubit systems. It is on this foundation that MSU-Q is built, and Mark will continue to be a vital part of our center.”

“Although there is great promise in quantum computing, the challenges are so daunting that significant research efforts are required to bring quantum computers to full fruition,” said Christlieb, MSU Foundation Professor. “MSU-Q brings together a strong multidisciplinary group of scientists to help move the new quantum age forward.”

MSU-Q is supported by the Office of the Vice President for Research and Innovation and the Colleges of Natural Science and Engineering. For more information, visit <https://msu-q.msu.edu/>. 🌐

International research cultivates great science, friendships

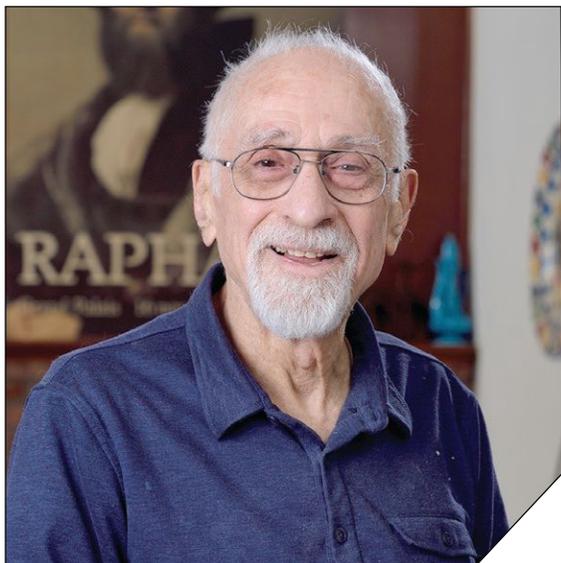
Travel abroad and international collaborative research have defined Aaron Galonsky's life. It's fitting, then, that one of his former graduate students recently established the Galonsky International Research Travel Award in his honor.

Ironically, prior to 1955, Galonsky, now a retired MSU physics professor, had no desire and no reason to travel abroad.

"I had hitchhiked up to Canada once, but I never thought I'd go to Europe—or any other country," said Galonsky, who was born in Brooklyn, New York.

"One night in 1955, someone put a bug about the wonders of Europe in my wife's ear," he said. "We went by ship—which was about half the price of propeller air travel."

After earning his undergraduate degree in physics from Brooklyn College in 1950 and his Ph.D. in physics from the University of Wisconsin in 1954, Galonsky worked at Oak Ridge National Laboratory



Aaron Galonsky

from 1954 to 1959, and in Wisconsin at the Midwestern Universities Research Association from 1959-1964. In 1964, drawn by the prospect of MSU's new cyclotron laboratory, Galonsky joined the MSU faculty. When Henry Blosser, the "father" of the laboratory took a leave, Galonsky served as the director.

In 1975, twenty years after Galonsky and his wife first went to Europe, Galonsky returned—this time by jet aircraft and with his entire family—

for a sabbatical year in Germany at a nuclear research institute near Aachen. He worked with many fellow scientists that year and developed close friendships. One of the closest was Adam Kiss, a physicist from Hungary. In 1981, when each was back in his own country, they formed a collaborative program jointly supported by the Hungarian Academy of Sciences and the U.S. National Science Foundation. For the next decade there was a flow of nuclear physicists between Budapest and East Lansing. Each of Galonsky's graduate students had at least one chance to work in the Budapest laboratory.

He proudly recalls his students' impressive accomplishments. Two of his graduate students went on to become professors at major universities. Others are

well-known for their work at national laboratories, medical facilities and large corporations across the country and abroad.

One former graduate student, Don Sackett (M.S., physics, '89; Ph.D., physics, '92) who was especially influenced by Galonsky's role in his life, established the endowed travel award in his honor this year. Sackett founded and is currently CEO of SciAps Inc., a Boston-based company

TRAVEL

"My intent for this travel award is for others to have overseas research experiences . . ."

specializing in portable analytical instruments.

Recipients of the Galonsky endowment must be graduate students or post-docs in the Department of Physics and Astronomy who participate in a scientific experiment outside of the United States for at least one month—giving them the opportunity to build relationships with international researchers, just as Galonsky did.

Galonsky retired from MSU in 2006.

"My life has been full of internationalism and it has passed on to my children and grandchildren," Galonsky said, noting that one of his granddaughters works for Google in Munich, Germany, and speaks Japanese when in Japan.

"My intent for this travel award is for others to have overseas research experiences, which result in great science and friendships," he added. 🌟

Student Honors

Joseph Chung entered MSU this fall as an Alumni Distinguished Scholar, which includes a scholarship covering tuition, room and board, and a stipend for up to eight semesters of undergraduate study at MSU; it is valued at approximately \$130,000 for in-state students. Chung, who is from Okemos, Mich., is majoring in physics and is excited about the support the scholarship will provide.

Chelsea Harris, a postdoctoral researcher, received a 2019 Frederick A. Howes Scholar in Computational Science Award, which is given to recent graduates of the DOE's Computational Science Graduate Fellowship program who not only demonstrate technical achievements in computational science but also outstanding leadership and character. As a postdoc, Harris implements state-of-the-art codes for high-order calculations of supernovae from massive stars with rotating cores.

Incoming graduate students **Brandon Barker**, **Carissa Myers** and **Catherine Nicoloff** were each awarded an NSF Graduate Research Fellowship (GRFP). The program recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering and mathematics disciplines pursuing research-based graduate degrees. Funding is for three years and covers tuition, fees and a stipend.

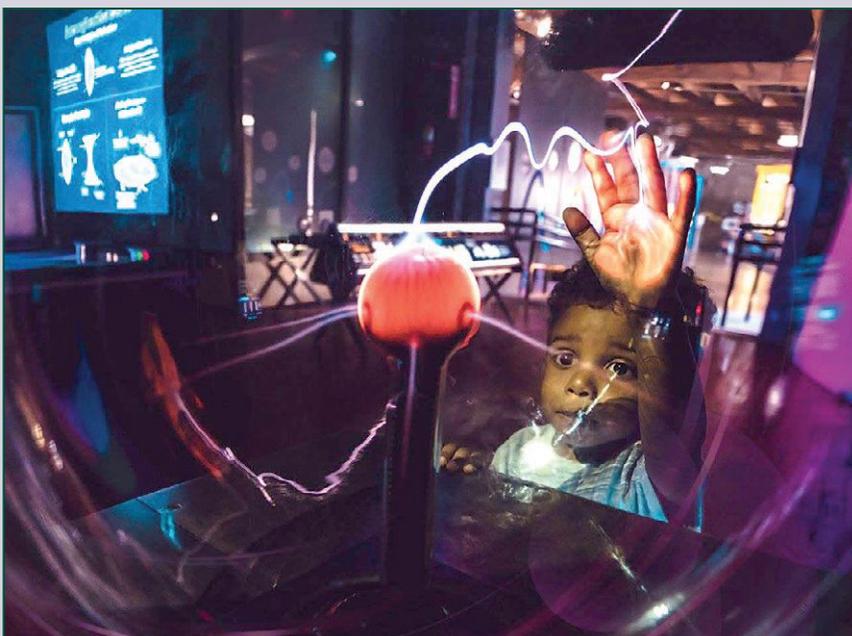
Graduate student **Zachary Matheson**, NSCL/FRIB, has been selected as a fellow of the U.S. Department of Energy's (DOE) National Nuclear Security Administration (NNSA) Graduate Fellowship Program (NGFP), which places highly qualified graduate students into yearlong assignments throughout NNSA. Fellows participate in professional development, training and networking opportunities with leaders from across the nuclear security enterprise. NGFP

fellows receive competitive salaries, benefits, tuition reimbursement and a \$10,000 travel/training allotment.

Ph.D. student **Dan Douglas** won a 2019 DOE Science Graduate Student Research Program award, which provides supplemental funds for graduate students to conduct research at a host DOE laboratory in collaboration with a DOE laboratory scientist for three to 12 months. Awards provide living and travel expenses to and from the DOE facility.

High Energy Physics (experimental) graduate student **Jake Calcutt** won a Fermi National Accelerator Laboratory Universities Research Association Visiting Scholars Award Program fellowship to support his work at the Fermi lab for up to one year. Support includes travel and lodging expenses during a series of short visits or salary support and round-trip travel expenses for an extended visit.

Physics & Astronomy Day a stellar success



This past spring, the MSU Department of Physics and Astronomy hosted its annual Physics & Astronomy Day at Impression 5 Science Center in Lansing, Mich., where students and faculty members led interactive activities for children of all ages.

Hundreds of attendees joined the department for an out-of-this-world day of physics and astronomy exploration, which featured dozens of themed hands-on activities. Kid-friendly exhibits gave participants the opportunity to smash atoms, play with lasers, experience liquid nitrogen in action, experience the night sky inside of an inflatable planetarium, and much more.

Physics and Astronomy Day is sponsored, in part, by the MSU Federal Credit Union. 🍀

NSF supports development of stellar collaboration

A s telescopes and experiments worldwide pull in astronomical data from light to electromagnetic radiation, gravitational waves, cosmic rays and, most recently, neutrinos, the need to create an infrastructure where this information can be combined, analyzed and shared in real time increases for scientists seeking to understand the most extreme events in the universe.

Known as multi-messenger astrophysics, this data-intensive science is transforming our scientific understanding of the universe and its origins but can only be realized if sufficient cyberinfrastructure is available to handle, combine and analyze the large-scale distributed data from all types of astronomical measurements.

To facilitate this science, NSF awarded MSU and nine other collaborating institutions a two-year, \$2.8 million grant to develop the concept for a Scalable Cyberinfrastructure Institute for Multi-Messenger Astrophysics (SCIMMA) to study the cosmos, beginning this past September.

SCIMMA would allow researchers to share multi-messenger observations to leverage NSF investments in large astronomical facilities and cyberinfrastructure, including the Laser Interferometer Gravitational-Wave Observatory (LIGO), IceCube Neutrino Observatory, Large Synoptic Survey Telescope and multiple cosmic ray and neutrino observatories.

With SCIMMA, scientists would be able to develop algorithms, databases and computing and networking cyberinfrastructure to help interpret multi-messenger observations to facilitate global collaborations that transcend the capabilities of any single institution.

Six MSU astronomers and astrophysicists are part of the multi-institution effort to develop the

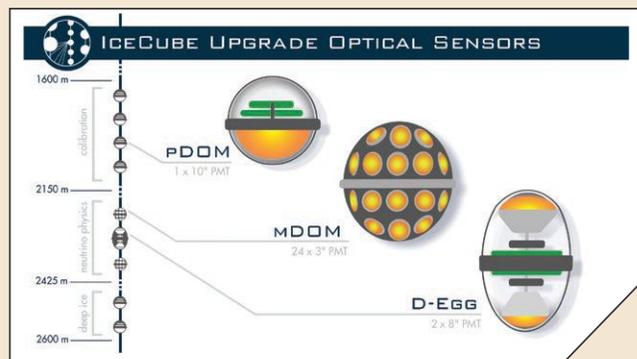


Michigan State is one of the primary universities involved in the IceCube Neutrino Observatory, an international collaboration of more than 300 physicists from 52 institutions in 12 countries.

SCIMMA concept. MSU's expertise in astrophysical theoretical modeling, software sustainability and key involvement at the IceCube Neutrino Observatory and the Amundsen-Scott South Pole Station positions it well as a key player in the collaborative project.

The conceptualization phase of SCIMMA will balance rapid prototyping, novel algorithm development and software sustainability to accelerate scientific discovery over the next decade and more. 📍

IceCube Neutrino Observatory upgrade



The upgrade will introduce seven strings of optical modules at the bottom center of the 86 existing strings, adding more than 700 new and enhanced optical modules to the 5,160 sensors already embedded in the ice beneath the geographic South Pole.

This past summer, the NSF approved full funding to upgrade the IceCube Neutrino Observatory detector during its 2022-23 polar field season. The principal goal of this upgrade is to enhance the cubic-kilometer detector to gain precision in studies of the oscillation properties of neutrinos, which can transform—or oscillate—from one type of neutrino to another as they interact with other particles and travel through space. Another goal is to better characterize the ice around the IceCube sensors and thereby obtain better performance with the existing detector, thus yielding more precise reconstructions of neutrinos at all accessible energies. The upgrade comes at a crucial time for the project as scientists look toward an exciting future of advancements in the field that the IceCube detector will provide.

MSU professor AIMS to teach nuclear physics in Africa

Pawel Danielewicz, professor, brought his teaching and research expertise to three different African countries as part of the African Institute for Mathematical Sciences (AIMS), a pan-African network of centers of excellence that offer structured master's degrees in mathematical sciences to talented African students.

"I spent a sabbatical semester at the Kavli Institute of Theoretical Physics in Santa Barbara and listened to some talks that invoked basic science as leverage for inducing societal change," said Danielewicz, who conducts nuclear theory research at MSU's National Superconducting Cyclotron Laboratory. "One of the talks was by Neil Turok, founder of AIMS South Africa, who pondered the expansion of the AIMS Initiative across the African continent."

As a result of those talks, Danielewicz decided to join AIMS as an instructor for intensive, three-week courses, each covering a semester's worth of material in Tanzania, Rwanda and Senegal between 2015 and 2019.

"I taught classical mechanics, and because my students had widely varying physics backgrounds, I had to work simultaneously on both basic and advanced levels," said Danielewicz, who also lived and ate meals with the students. "It was inspiring to encounter a lecture room full of students working at 2:00 a.m. on their homework and projects."



Pawel Danielewicz (center) with students from Senegal on their last day of class.

The resounding success of Danielewicz's time with AIMS rippled out from Africa to MSU. Six of his AIMS alumni were recruited into NatSci graduate programs, including three in physics and astronomy. His co-lecturer University of Lagos also became a postdoctoral researcher and instructor in MSU's Department of Mathematics. 🌱

Energized undergrads study the matter of physics education in Ghana

Five physics and astronomy undergraduate students received \$6,000 from MSU's Year of Global Africa initiative, along with additional funds from the department, to research the state of Ghanaian physics education.

In August, two of the undergraduates, Evan Brook and Matt Ring, along with Danny Caballero, a faculty member who conducts research on physics teaching and learning, used the funds to visit high schools in Cape Coast and the Volta Region. The team's report of teachers and students in action revealed the liberating and curiosity-driven results of physics education for Ghanaian students and communities first-hand.



Matt Ring (far left), Danny Caballero (second from right) and Evan Brook (far right) with students and teachers outside of Mafi-Kumase Senior High School in Ghana.

"Traveling to Ghana taught me the value and challenge of implementing what I've learned through research," said Ring, an MSU senior who plans to pursue a joint Ph.D. program in machine learning and public policy. "Making meaningful change requires working with others and sharing expertise."

"How teachers in Ghana think about physics education—its importance to the people of Ghana and what they see as needing improvements—is not well-known to the physics education community in the U.S.," Caballero said. "Having an exchange about teaching and learning in physics offers great potential to learn from each other and improve and expand our understanding of education in both spaces."

Besides a return trip to Ghana, the group plans to establish primary sources of funding for Ghanaian physics classes and develop partnerships between MSU instructors and students and their Ghanaian counterparts.

Other undergraduates involved in the project are Gabriel Moreau, Aalayah Spencer and Dylan Smith. 🌱

Game app teaches kids quantum chromodynamics

Parents frustrated by children unable to understand their physics assignments now have a tool to help even the most distracted physics students focus on scientific concepts with greater enthusiasm: Quantum 3, a phone-based physics game that introduces some of quantum physics' central concepts in an easily understood and attractive way.

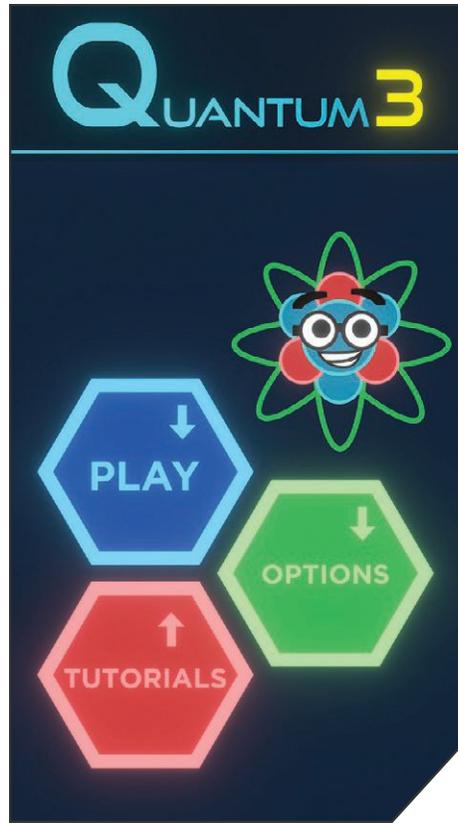
Huey-Wen Lin, assistant professor of physics and astronomy, recently completed developing Quantum 3 to help K-12 kids, particularly girls, learn about quantum chromodynamics (QCD).

QCD is a theory that governs the interactions of subatomic particles that form all stable matter—and an important part of the standard model of particle physics.

Although QCD is responsible for our existence and mass by making the formation of stable elements possible, few people learn about QCD unless they are pursuing a graduate degree in physics, due to the extensive math and science required for full understanding.

Lin, however, knows that some parts of QCD can be learned even by kids—and saw no reason to put off engaging their understanding of fundamental science principles—and perhaps sparking a long-term interest in the STEM fields.

“The game is designed for K-12 kids,” said Lin, who developed the game with funds she received through a National Science Foundation Early CAREER



The Quantum 3 game, developed by Huey-Wen Lin and her students, is a phone-based application that helps K-12 kids learn about quantum chromodynamics, or QCD.

award. “My own daughters have been my most loyal beta-testers. We’ve also had adults at outreach events play with an early version of the game and enjoy it.”

To make the game, Lin worked with a team of MSU undergraduate students and provided them with a QCD curriculum and skeleton of the basic design. These students, Tristan

Özkan, Roman Firestone, Colleen Little, Rebecca Roman and Harrison Sanders, interned with MSU’s Games for Entertainment and Learning (GEL) Laboratory to program the game, gaining experience with putting a game together and bragging rights for their work, including a resume line.

Because one of Lin’s goals is to bring more women into the physics and coding fields, the game’s design follows the Match 3 genre, which generally attracts girls more than other game structures without alienating boys. In such games, a player selects tiles on a grid to swap elements. If a row or column of three matching tiles is formed, those tiles disappear from the grid and are replaced with new tiles. Additional bonuses are given for forming matches of more than three tiles.

The game requires learning simple rules of quantum chromodynamics to progress, but by leveraging the willingness of players to engage with the rules of an entertaining game, the game almost effortlessly helps players absorb the necessary physics principles to continue.

MSU’s Games for Entertainment and Learning Lab provided the infrastructure to develop the game. The game is now available for download on Google Play and at the Apple App Store. 🎮

Contact Us

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Women in Physics meeting provides networking opportunities

Hundreds of women enrolled in physics programs across the United States attended the Conferences for Undergraduate Women in Physics (CUWiP) held simultaneously across the country in January 2019. More than 150 of them gathered on MSU's campus for the Midwest regional session, one of CUWiP's 12 regional conferences. Organized through the American Physical Society, the conferences are designed to support women in physics and foster professional development.

Vashi Sawtelle, assistant professor, explained that only about 20 percent of bachelor's degrees in physics in the United States are awarded to women, so attending a conference with 150 women can be a powerful experience, especially if the attendee is from a small school—and the only woman in her department.

“These conferences bring in speakers and workshop leaders who address what it's like to be someone who is underrepresented in the field and talk about what it's like to persevere through that—and why it matters,” Sawtelle said.

Students who attended the conference appreciated meeting other women who share their professional interests and learning they were not alone in the field. Several developed skills that will help them meet the challenges of being an underrepresented minority in their department, including networking and isolation.

Students paid \$45 for the three-day conference, which included meals and lodging. They networked, attended



More than 150 women attended the Midwest regional session of the national Conferences for Undergraduate Women in Physics in January 2019.

a poster session and presentations by physicists and industry professionals, and toured MSU's cyclotron, physics labs and the planetarium.

The workshops helped a number of students broaden their understanding of career opportunities in industry and graduate school programs. Several students realized that they could explore both options without sabotaging their ultimate choice. Conference success! 🍀