



DEPARTMENT OF

Physics & Astronomy

MSU College of Natural Science | Newsletter for Alumni and Friends

From the Department Chair...

Our department has had a great year with increasing student enrollments, the hiring of excellent new faculty (page 3) and some highly important funding successes. Our graduate recruiting class this year was excellent, with more than 40 incoming students, including many winners of College of Natural Science and university fellowships. The undergraduate program also continues to grow, with more than 350 undergraduates currently majoring in physics and astronomy—which is in the top 20 nationwide, according to American Institute of Physics statistics.

A new Physics Education Research Lab (PERL) is off to a flying start, with strong funding from local and federal sources. It is further strengthened by the arrival of a new faculty member, Vashti Sawtelle, whose primary appointment is with MSU's Lyman Briggs College.

The construction of the Facility for Rare Isotope Beams (FRIB), led by University Distinguished Professor Thomas Glasmacher as project manager, is now in overdrive, with the DOE's Office of Science project assessment review committee announcing in June that the project is ready for technical construction. Due to the large National Superconducting Cyclotron Laboratory (NSCL) and FRIB budgets, the department is in the top 10 nationally in the amount of federal funding received. Read more about this extraordinary project on page 9.

A second notable event this year was the announcement that the National Science Foundation's (NSF) JINA-CEE Physics Frontiers Center was renewed for another five years, with MSU becoming the lead organization. These centers are among the most

prized and prestigious centers funded by the NSF, and accolades go to Professor Hendrik Schatz and his team for this success. The arrival of a new physics and astronomy/NSCL Hannah Chair (Witek Nazarewicz) and two young NSCL faculty members (Jaydeep Singh and Ulrike Hager) further strengthens the science programs in NSCL, FRIB and the department.

The high energy physics group hired two new experimentalists—Tyce DeYoung and Kendall Mahn. Both work on neutrino physics, complementing the excellent experimental group that focuses on physics in the "Higg's sector" (Brock, Fisher, Huston, Schwienhorst). These hires also establish Michigan State as a Center of Excellence in Particle Astrophysics, with participation in the HAWC collaboration (Linnemann, Tollefson, DeYoung) and, most recently, the IceCube collaboration (DeYoung, Mahn), for which DeYoung is deputy spokesperson (see story on page 11). This new emphasis in particle astrophysics, in combination with the nuclear astrophysics program encompassed by JINA-CEE, and terrific results announced by the young and active astronomy group, provides us with a high profile in astronomy and astrophysics.

High-profile research activities in the condensed matter group include the construction of a femtosecond resolution electron microscope (Ruan); understanding the physics behind quantum devices for next generation digital memories (Birge); and elucidating the physics of nonlinear and quantum nanobeams with potential applications to sensors, actuators and oscillators (Dykman). A search for a faculty person engaged in quantum transport or nano-dynamics is ongoing. A notable recent result in biophysics, by the Lapidus research group, is the elucidation of co-

factor molecules that inhibit misfolding of proteins implicated in degenerative diseases such as Parkinson's, Alzheimer's and Huntington's disease (read more on page 6). And Jay Strader is doing some interesting work related to astrophysical problems in the local universe—the Milky Way and nearby galaxies (see story on page 10).

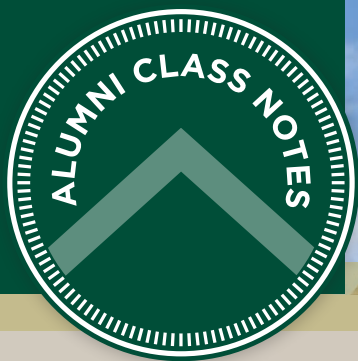
Several endowments and planned gifts have been initiated including the Cowen Family Graduate Fellowship, the Schroeder Graduate Fellowship endowed by physics alumnus John Woollam and a planned gift by physics and astronomy business operations and personnel manager Marc Conlin, who has worked in the department for more than 40 years and earlier established an endowment to support a staff award. You can read more about these important gifts on pages 7 and 8.

This year is the 50th anniversary of MSU's Abrams Planetarium, and it is being re-invigorated with the arrival of a dynamic new director (Shannon Schmoll), the installation of a state-of-the-art digital projector and a diverse array of new activities. Read more about this on the back page of this newsletter.

Please let me know if you would like to run an alumni or other event related to the department, and thanks, as always, for your continuing support! ♡



*Phillip Duxbury
Chair
Department of Physics
and Astronomy*



Bruce Beckert, physics, '52, is a principal of Beckert & Hiester, Inc., Saginaw, Mich. The company manufactures industrial dust collectors and air pollution control equipment and collection systems. Beckert has a longstanding interest in aviation and has built an RV-6 (a light sport kit airplane) by Vans Aircraft. He is 85 years of age and still going strong; retirement is possible, but not imminent.

Marilyn Velinsky Rands, Masters, physics, '64, retired in May as professor emeritus after 38 years as a physics professor at Lawrence Technological University in Southfield, Mich.

Carl Brandon, physics, '66, professor of science and aeronautical engineering technology and director of the CubeSat Laboratory at Vermont Technical College in Randolph Center, built and directed the launch of the first miniature satellite by a New England college/university in November 2013. The mission of the satellite is to make navigation estimates for a future moon project.

Craig Barrows, physics, '67, although officially retired in 2011, is currently an adjunct physics instructor at Highland Community College in Wamego, Kansas.

Kenneth Foster, physics, '67, just retired as professor of bioengineering at the University of Pennsylvania, Philadelphia, where he has been on

the faculty since 1976. He continues to teach his graduate course on biomedical engineering.

Lewis Snyder, Ph.D., physics, '67, retired as chair of the astronomy department and as professor of astronomy at the University of Illinois at Urbana-Champaign in 2005. Following his graduation from MSU, he signed on as postdoctoral researcher at the National Radio Astronomy Observatory (NRAO) in Charlottesville, Va. In 1968, he and his colleagues detected the first interstellar organic polyatomic molecule, formaldehyde, on the NRAO 140-foot telescope in Green Bank, WV. The discovery spawned an entire field of research.

William (Bill) Skocpol, physics, '68, was promoted to emeritus professor of physics this May after 27 years of teaching and research on Hi-Tc superconductors and administration at Boston University. Prior to joining Boston University, he was a researcher at Bell Laboratories, helping to create the field of nano-electronics.

Frank Sottile, physics and mathematics, '85, began a four-year appointment in May 2014 as a visiting adjunct professor in the Department of Combinatorics and Optimization at the University of Waterloo, Ontario, Canada. He also joined the editorial board of the American Mathematical Monthly, and is spending fall 2014 as a visiting scientist at the Simons Institute for Theoretical Computer Science in Berkeley, Calif.

Carlos Maidana, M.S., physics, '03, has published a booklet, "Thermo-magnetic Systems for Space Nuclear Reactors: An Introduction," with Springer Publishing. He has also been appointed as a lecturer of mechanical engineering at Chiang Mai University in Thailand, and has incorporated his own scientific, technical and business consulting office in the United States and Europe.

Brent Barker, M.S., physics, '09; Ph.D., physics '14, recently accepted a position as assistant professor of physics at Roosevelt University in Chicago. As the sole full-time physics faculty member there, he manages the entire curriculum and the instructional labs.

Contact Us

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Photographs courtesy of: Lynette Cook, Gemini Observatory (Page 5); Hubble Telescope imagery (Page 10); Sven Lidstrom, IceCube/NSF (Page 11); MSU Department of Physics and Astronomy; MSU Office of Communications and Brand Strategy; Harley Seeley; and University of Tennessee-Knoxville (Page 2).



Nazarewicz named first Hannah Distinguished Professor at FRIB

Witold “Witek” Nazarewicz joined the Facility for Rare Isotope Beams (FRIB) at MSU as a Hannah Distinguished Professor of physics in August. He is also a faculty member with MSU’s Department of Physics and Astronomy and the National Superconducting Cyclotron Laboratory.

Nazarewicz is an international leader in theoretical nuclear physics and is widely recognized for his research on the physics of exotic nuclei. As scientific director of the Holifield Radioactive Ion Beam Facility from 1999 to 2011, he guided the program to many experimental breakthroughs in the areas of rare isotopes and nuclear astrophysics. He is the recipient of the prestigious Bonner Prize in nuclear physics from the American Physical Society. Nazarewicz is a fellow of the American Association for the Advancement of Science, the American Physical Society and the U.K. Institute of Physics, and has received many other honors and awards.



Nazarewicz

“The Facility for Rare Isotope Beams will be a world-leading laboratory for the study of atomic nuclei,” Nazarewicz said. “Experiments with intense beams of rare isotopes produced at FRIB will guide us toward a comprehensive description of nuclei, elucidate the origin of the elements in the cosmos, help provide an understanding of matter in neutron stars

and establish the scientific foundation for innovative applications of nuclear science to society.”

Prior to coming to MSU, Nazarewicz was a professor of physics at both the University of Tennessee in Knoxville and Warsaw University, Poland. He is also a corporate fellow at the Oak Ridge National Laboratory.

New Faculty

The Physics and Astronomy Department welcomed several new faculty members in August:

Tyce DeYoung joined the department as an associate professor. His research focuses on experimental particle astrophysics as a means to investigate fundamental particle physics. Prior to coming to MSU, DeYoung was an associate professor in the department of physics at Pennsylvania State University. He received his Ph.D. in physics from the University of Wisconsin–Madison.

Ulrike Hager is an assistant professor in the National Superconducting Cyclotron Laboratory (NSCL), and has a joint appointment in the department. Her research focuses on measuring reaction rates important for nuclear astrophysics. Prior to coming to MSU, Hager was an assistant professor in the department of physics at the Colorado

School of Mines. She received her Ph.D. in physics from the University of Jyväskylä in Finland.

Kendall Mahn is an assistant professor with an interest in high energy physics. Her research focuses on the small subatomic particle, the neutrino. She was a postdoctoral fellow at TRIUMF, Canada’s national laboratory for particle and nuclear physics, before coming to MSU. Mahn received her Ph.D. in high energy physics from Columbia University in New York City.

Vashti Sawtelle has a majority appointment in the Lyman-Briggs College, however her research program is centered in the department’s Physics Education Research Lab. She studies how

learning environments support (or inhibit) students from diverse backgrounds in learning physics. Prior to coming to MSU, Sawtelle was a postdoctoral research associate at the University of Maryland. She received her Ph.D. in physics from Florida International University in Miami.

Jaideep Singh is an assistant professor in the National Superconducting Cyclotron Laboratory (NSCL), and has a joint appointment in the department. His research focus is experimental nuclear physics, including creating, manipulating and detecting spin-polarized nuclei. Singh was a postdoctoral research scientist at the Technische Universität München in Munich, Germany, prior to coming to MSU. He received his Ph.D. in physics from the University of Virginia in Charlottesville.

Faculty Honors



Glasmacher

University Distinguished Professor **Thomas Glasmacher** has been named a 2013 fellow of the American Association for the Advancement of Science (AAAS). This national recognition is awarded to researchers for their efforts to advance science or its applications. Glasmacher, who is also project manager for the Facility for Rare Isotope Beams (FRIB), was honored for his contributions to the understanding of the properties of exotic atomic nuclei and leadership

in the management and development of accelerators of rare isotopes. He was formally recognized Feb. 15, 2014, during the annual AAAS meeting in Chicago.



Donahue

Professor **Megan Donahue** received the William J. Beal Outstanding Faculty Award at the 2014 MSU Awards Convocation Feb. 11. The award recognizes outstanding contributions to education and research and is one of the highest honors given to faculty members by the university. Donahue was recognized for her contributions to the fields of cosmic structure and galaxy evolution.

She is well known for her pioneering work on measuring the x-ray temperature function of the intracluster medium at high redshift using two leading x-ray satellite facilities.

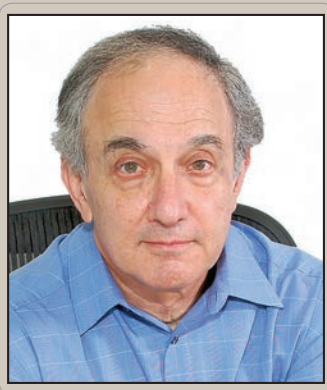
Six members of the department received 2014-2015 awards from the College of Natural Science: Associate Professor **Wade Fisher**, Teacher-Scholar Award; Associate Professor **Stuart Tessmer**, Undergraduate Teaching Award; Professor **Stephen Zepf**, Junior Faculty Mentoring Award; Assistant Professor **Alex Levchenko**, Postdoctoral Mentoring Award; Dr. **Reza Loloe**, Support Staff Award; and Associate Professor **Carl Schmidt** and Associate Professor **Stuart Tessmer**, Faculty Teaching Prizes.

Retirements



Baldwin

Professor Emeritus **Jack Baldwin** will retire Jan. 1, 2015. He joined the department in 2000. His research centers on the use of emission lines to study the physical nature of active galaxies. This work led to studies of the Orion nebula and planetary nebulae, both to understand their nature and to calibrate emission-line techniques on simpler, nearby objects. In 2007, Baldwin received the MSU Distinguished Faculty Award.



Golding

Professor **Brage Golding** retired in May 2014. He joined the department in 1991 after 24 years on the technical staff of AT&T Bell Laboratories in Murray Hill, N. J. He was the director of MSU's Center for Fundamental Materials Research from 1993 to 1996, and the director of the Center for Sensor Materials, an NSF-supported Materials Research Science and Engineering Center, from 1994 to 2004. He is a fellow of the American Physical Society.



Pope

Professor **Bernard Pope** retired Jan. 1, 2014, after working for 32 years in the department. He was actively involved in the physics done with the ATLAS experiment at CERN in Geneva, Switzerland. This experiment detects and measures proton-proton collisions in CERN's Large Hadron Collider, the world's largest and most powerful particle collider. He is a fellow of the American Physical Society. In 2010, Pope received the MSU Distinguished Faculty Award.



\$11.4 million NSF grant aids “elemental” research

MSU is leading a National Science Foundation-funded research project that is investigating how the elements of the universe evolved. The five-year, \$11.4 million grant will enable researchers to focus on how the universe went from an original three elements—hydrogen, some helium and a little bit of lithium—to nearly 100 known naturally occurring elements today.

Hendrik Schatz, professor of physics and astronomy, and a researcher in MSU’s National Superconducting Cyclotron Laboratory (NSCL), will lead the project.

This work will be done, said Schatz, by going back in time, astronomically speaking, to interpret what he calls the “chemical fingerprints” of the elements created by celestial events such as supernovas.

In a process that continues today, stars create more and more complex elements, then explode as supernovas or gamma ray bursts, scattering the newly created elements into space for another generation of stars to use. Cycle after stellar cycle, stars become steadily richer in heavier and more complex elements.

“Chemical tracers found in very old stars form a ‘fossil’ record of chemical evolution and reveal how nature has, step by step, built up the elements that now form the basic building blocks of our world,” Schatz said. “We hope to find more of these chemical fossils through astronomical observations.”

These observations will then be interpreted by studying the same element-creating nuclear reactions in accelerator labs such as MSU’s NSCL, and similar labs at the University of Notre Dame, the Argonne National Laboratory and others.



MSU is leading an NSF-funded research project that is studying how the elements of the universe evolved. It's believed the elements are created through the explosions of massive stars.

The team will incorporate the experimental data into advanced computer models of the process of chemical evolution through a virtual galaxy that resembles our Milky Way.

The research also will delve a bit deeper into what are known as neutron stars – super dense stars that form when a large star explodes and its core collapses.

Again, by re-creating the conditions of a neutron star in the lab, the scientists hope to determine the characteristics of the stars’ matter, as well as study the violent explosions that occur on their surfaces and the merging of the stars into black holes.

“Our goal is to investigate the reactions that power the surface explosions, and to determine the nature of the exotic

matter that makes up the interior of neutron stars,” Schatz said.

The research is being conducted through the Joint Institute for Nuclear Astrophysics Center for the Evolution of the Elements, an NSF-funded Physics Frontiers Center that brings together experimentalists, theorists and observers in nuclear physics and astronomy to address two basic questions—the creation of the elements during the first billion years after the Big Bang, and the nature of dense nuclear matter that makes up the cores of neutron stars and their remnants.

Other partners in the project include Arizona State University, the University of Notre Dame, the University of Washington and 18 other institutions from six countries. 🌍



MSU physicists push new Parkinson's treatment toward clinical trials

The most effective way to tackle debilitating diseases is to grab them at the start and keep them from growing.

Research being conducted by MSU physicists shows that a small “molecular tweezer” keeps proteins from clumping, or aggregating, the first step of neurological disorders such as Parkinson's disease, Alzheimer's disease and Huntington's disease.

These results are pushing the promising molecule toward clinical trials and toward actually becoming a new drug, said Lisa Lapidus, MSU associate professor of physics and astronomy.

“By the time patients show symptoms and go to a doctor, aggregation already has a stronghold in their brains,” she said. “In the lab, however, we can see the first steps, at the very place where the drugs could be the most effective. This could be a strong model for fighting Parkinson's and other diseases that involve neurotoxic aggregation.”

Lapidus' lab uses lasers to study the speed of protein reconfiguration before aggregation, a technique Lapidus pioneered. Proteins are chains of amino acids that do most of the work in cells. Scientists understand protein structure, but they don't know how they are built — a process known as folding.

Lapidus' team has shed light on the process by correlating the speed at which an unfolded protein changes shape, or reconfigures, with its tendency to clump or bind with other proteins. If reconfiguration is much faster or slower than the speed at which proteins bump into each other, aggregation is slow, but if reconfiguration is the same speed, aggregation is fast.

Srabasti Acharya, a doctoral candidate in Lapidus' lab, tested the molecule, CLR01, which was patented jointly by researchers at the University of Duisburg-Essen (Germany) and UCLA. CLR01 binds to the protein and prevents aggregation by speeding up reconfiguration.

“It's like a claw that attaches to the amino acid lysine, which is part of the protein,” Acharya said.



Srabasti Acharya, MSU graduate student (left), and Lisa Lapidus, MSU associate professor of physics and astronomy, study protein folding using optical spectroscopy and microfluidics.

This work was preceded by Lapidus' research involving curcumin, a compound found in the spice turmeric.

“We are using physics to better understand biology to help cure actual diseases.”

“Although the spice molecules put us on a solid path, the molecules weren't viable drug candidates because they cannot cross the blood-brain barrier, or BBB, the filter that controls what chemicals reach the brain,” Lapidus said. “It's the BBB, in

fact, that disproves the notion that people should simply eat more spicy food to stave off Parkinson's disease.”

Spicy misconceptions notwithstanding, CLR01 mimics curcumin molecules' ability to prevent aggregation. But unlike the spice, CLR01 can cross over the BBB and treat its targeted site. Not only do they go to the right place, but CLR01 molecules also work even better because they speed up reconfiguration even more than curcumin. Additionally, Acharya showed that CLR01 slows the first step of aggregation, and the results from the study map out a clear road map for moving the drug to clinical trials.

“This is fascinating work,” Acharya said. “We are using physics to better understand biology to help cure actual diseases.”

To help move the research to the next phase, Gal Bitan, a professor at UCLA, is using crowdsourcing to raise funds for the clinical trials. 🌟



A dedicated Spartan gives back

With his combined time as an MSU student and as an employee in the MSU Department of Physics and Astronomy, Marc Conlin has invested some 50 years in Michigan State. His Spartan legacy goes beyond eager learning, devoted professional acumen and trusted leadership to significant financial support—in the form of cash and future gifts.

“ . . . I can see the difference that endowments make, both in accomplishing our mission and in enabling great people to do great work.”

Conlin received his bachelor's degree in engineering in 1969 and his MBA in 1972—both from MSU. As an undergraduate student, he was employed in the physics and astronomy department, working in the electrical shop and the stock room. After receiving his bachelor's degree, he accepted a full-time job in the department, working his way up to the position he currently holds—business operations and personnel manager. In 2009, Conlin was recognized with the Jack Breslin Award, MSU's highest honor for non-academic staff.

Marc said that the reasons for giving back to the university are easy to list.

“I have been fortunate to have gone to school here, and to work here with the people that I do,” he said. “There is vision and foresight here [in the department] to keep us in the forefront of current teaching and research. But I can see the difference that endowments make, both in accomplishing our mission and in enabling great people to do great work.”

With cash and future gifts incorporated in his estate plans, including from his university 403b retirement plan, Conlin has provided endowed support for graduate students in physics and astronomy (and engineering), and has created an endowment for recognizing and empowering the outstanding service of university staff in the physics and astronomy department.



Conlin

As an engineer with an MBA and recognized skills, Marc could have easily launched a career in business and industry, but he said he never gave serious thought to leaving MSU.

“I came to school and then I started working,” he said. “I never got bored. I have always been challenged to learn and do new things, trying to do things better or more efficiently. No day is the same, but I use both my engineering and business background every day.”

Indeed. No one is encouraging Marc to take an early retirement. 🍀

Empower Extraordinary

On Oct. 24, MSU publicly launched its latest capital campaign, Empower Extraordinary, with an overall fundraising goal of \$1.5 billion. The multi-year project began in 2011 and will continue until 2018. Through this campaign, the College of Natural Science seeks to raise \$74 million in private support to ensure that its outstanding students, staff and faculty members will have the critical resources and training they need to lead the world in education and research in the 21st century and beyond. For more details about Nat Sci's campaign goals and progress, visit <http://givingto.msu.edu/college/college-of-natural-science.cfm>.



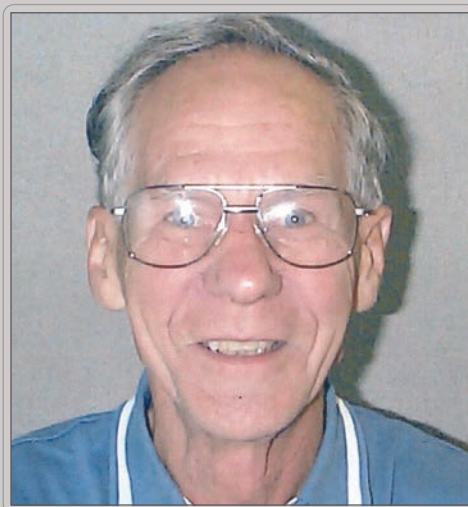
Alum establishes endowed fellowship in honor of emeritus professor

Alumnus John A. Woollam (M.S., physics, '63; Ph.D., solid state physics, '67) has established the Peter A. Schroeder Physics Fellowship in honor of the Emeritus Professor of physics and astronomy.

Schroeder, a condensed matter experimental physicist, joined MSU's physics and astronomy faculty in 1961, becoming a full professor in 1968. He taught at all levels, from large undergraduate core courses to specialized graduate courses. He advised 14 graduate students during his tenure.

He had a special interest in areas where physics impinges directly on social issues; he taught courses on the physics of nuclear war and chaired a nuclear war study group from 1984-1988. He retired in 1997.

Schroeder says he is "amazed" about the endowment set up in his honor and noted that Woollam—who was Schroeder's second graduate student at MSU—is "a great entrepreneur who has done extremely well with his business."



Schroeder

Woollam founded the J.A. Woollam Company in 1987 as a spin-off from the University of Nebraska. Headquartered in Lincoln, the company has grown to become a worldwide leader in spectroscopic ellipsometry—an optical technique for investigating the dielectric properties of thin films. It employs more than 45 people and has secured more than 100 patents.

Woollam is now semi-retired from his position as the George Holmes

Distinguished Professor at the University of Nebraska.

In June 2012, Woollam invited Schroeder and all of his past Ph.D. students to a get-together at Pretty Lake near Kalamazoo, Mich., where they presented Schroeder with a booklet titled "Advisor Extraordinaire," which contained comments from all of the students he had advised.

Schroeder and his wife, Gwyneth, have long recognized global warming as a serious problem — specifically, how the Earth's food production will have to increase to meet the needs of the expanding population. Schroeder hopes that some of the endowment fund can be used for research projects that will address this concern.

"We are using more of the Earth's resources than what we can replenish," Schroeder said.

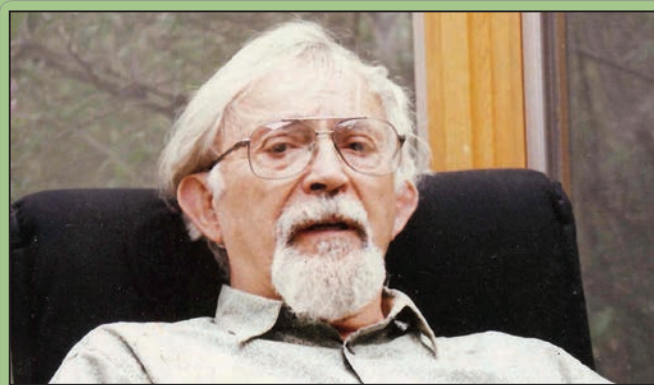
M.S. or Ph.D. students majoring in condensed matter physics who are U.S. citizens or permanent residents are eligible to apply for the Schroeder fellowship, with preference given to students inclined to work in industry, rather than academia.

Cowen Family Fellowship attracts top graduate students

The Cowen Family Fellowship was established in MSU's Department of Physics and Astronomy in February 2014 in memory of the life and career of Jerry Cowen, who received his Ph.D. in physics from MSU in 1954 and joined the faculty in 1955.

This \$350,000 fund will be used to create an endowed fellowship program to be used to attract the best graduate students to work with the faculty member recognized as the Jerry Cowen Endowed Chair.

The Jerry Cowen Endowed Chair was created by Randolph (Randy) Cowen



Cowen

(*74, arts and letters/Honors College), former CIO at Goldman Sachs, and his wife, Phyllis Green, in memory of his father.

"My father dedicated his life to research in the field of solid state physics," said Randy Cowen. "With the Jerry Cowen Endowed Chair, MSU will have one of the best research efforts in the country in the field of solid-state physics; this cutting-edge research will attract a new generation of graduate students like my father."

Matthew Comstock, who joined the MSU faculty in 2012, is currently the Jerry Cowen Endowed Chair in Experimental Physics. The first holder of this endowed chair was installed in 2008.



The Facility for Rare Isotope Beams takes off

After more than five years of design, the securing of funding and preliminary construction activities, work has officially begun on the civil construction for the Facility for Rare Isotope Beams (FRIB). A groundbreaking ceremony was held March 17 near the worksite at Bogue and Wilson roads on the Michigan State University campus. The 2014 federal budget included \$55 million to support construction of FRIB.

FRIB will be a new national user facility for nuclear science, funded by the Department of Energy Office of Science (DOE-SC), MSU and the State of Michigan. Operated by MSU, FRIB will provide intense beams of rare isotopes—short-lived nuclei no longer found on Earth. FRIB will enable scientists to make discoveries about the properties of these rare isotopes in order to better understand the physics of nuclei, nuclear astrophysics, fundamental interactions and applications for society.

As the next-generation accelerator for conducting rare isotope experiments, FRIB will allow scientists to advance their search for answers to fundamental questions about nuclear structure, the origin of the elements in the cosmos and the forces that shaped the evolution of the universe.

FRIB builds upon the expertise and achievements of the National Superconducting Cyclotron Laboratory (NSCL), a National Science Foundation (NSF) user facility at MSU. Since 2001, NSCL's coupled cyclotron facility, one of the world's most powerful rare isotope user facilities, has been conducting experiments on rare isotopes, elevating our understanding of nuclei to new levels.



Under construction on campus and operated by MSU, FRIB will enable scientists to make discoveries about the properties of rare isotopes in order to better understand the physics of nuclei, nuclear astrophysics, fundamental interactions and applications for society.

FRIB moves beyond NSCL's discoveries to envision the next-generation technology needed for next-generation rare isotope experiments. The foundation of this vision—now the design of FRIB—is to use fast, stopped, and reaccelerated rare isotope beams produced by fragmentation to yield consistently high intensities of beams in minimal beam development times.

“Together we will make FRIB real.”

“Together we will make FRIB real,” said Thomas Glasmacher, MSU Distinguished Professor of physics and astronomy and FRIB project manager. “The whole FRIB project team stands ready to realize the

opportunity to support the mission of the DOE Office of Science and the aspirations of the international nuclear science community.”

It's also anticipated that FRIB will contribute nearly \$1 billion in economic activity to the region. That includes construction, spinoffs and annual DOE operational funding once FRIB begins operations.

Excavation will extend into 2015 and will yield a site 1,500 feet long by 70 feet wide and 40 feet deep, ready for construction. Concrete will be poured soon thereafter, followed by structural steel.

The project is scheduled for completion in June 2022.

To keep up on the latest FRIB progress, visit frib.msu.edu/about. 

Serendipity: It's in the stars

Serendipity is what launched Jay Strader on his career path in astrophysics. But it's his passion and hard work that has put him into full orbit.

Strader, MSU assistant professor of physics and astronomy, said he started out as an economics/math major at Duke University. To fulfill a science requirement, he enrolled in an astrophysics class.

"I found that astrophysics was more interesting and more intellectually challenging than economics," Strader said. "Because of that class, I switched my major to physics."

He completed his Ph.D. at the University of California, Santa Cruz, focusing on globular star clusters, and was a postdoctoral fellow at Harvard for five years prior to coming to MSU in 2012.

"If that astrophysics class had not been offered back then . . . I don't know what I would be doing today!" Strader said.

His current work focuses on astrophysical problems in the local universe—the Milky Way and nearby galaxies.

"Most of my research has focused on studying compact objects, which is 'astronomer speak' for neutron stars and black holes—things that are left over when stars die. I study both of these inside globular star clusters."

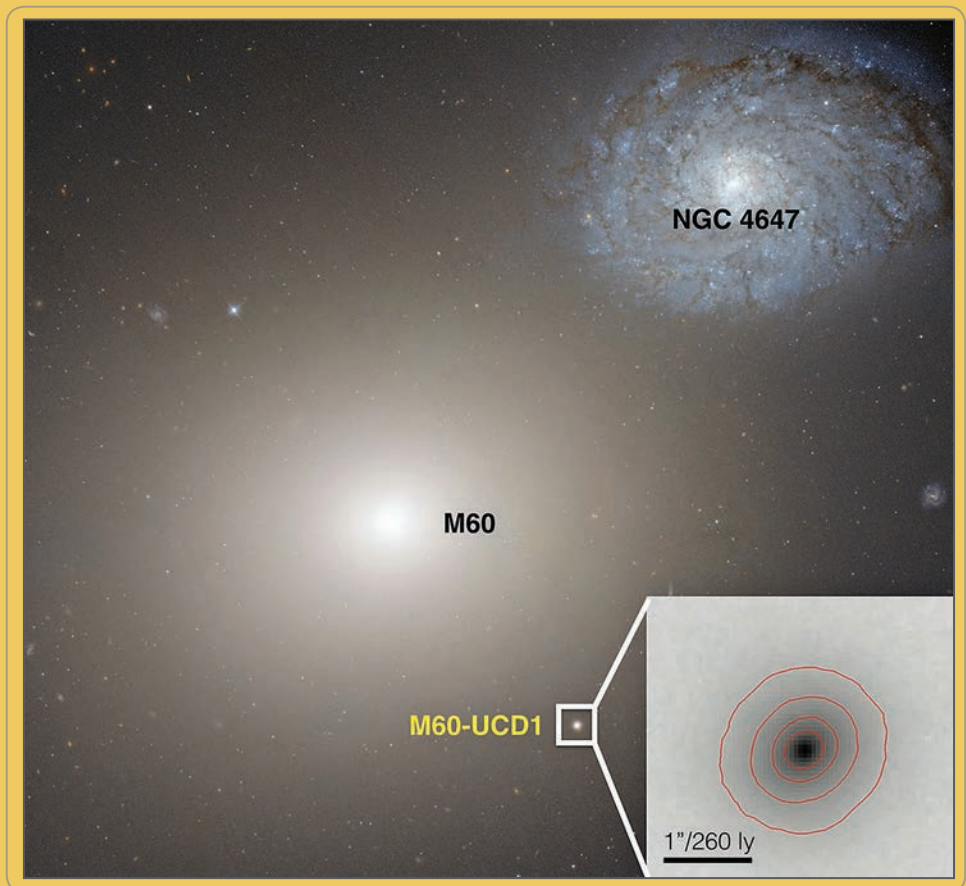
In September 2013, Strader led a team of international researchers credited with discovering the densest galaxy ever—now known as M60-UCD1.

"We hypothesized that because this object was so massive, it wasn't plausible that it was a star cluster," Strader said. "We think it was the central core of a galaxy, the outer parts of which had been ripped apart as it came close to a more massive galaxy."

Data gathered during this study also revealed a bright x-ray source in its center—which would be indicative of a giant black hole.

In September 2014, Strader was part of the research team that did, in fact, discover a huge black hole at the center of the ultra-compact galaxy known as M60-UCD1.

"Stars close to a black hole move very fast, because they feel the gravity of that black hole," Strader explained. "So by using extremely high-resolution detailed data, closer to the center, we were able to look directly for the black hole."



A team of researchers, led by MSU astronomer Jay Strader, has discovered a black hole at the center of an ultra-dense galaxy known as M60-UCD1. This image compares the size of that galaxy to the gigantic NGC 4647 galaxy.

This high-resolution data is what led to the 2014 discovery, according to Strader.

This finding implies that there are many other compact galaxies that contain supermassive black holes, according to a NASA news release. And because large black holes are not found in star clusters, this finding also suggests that dwarf galaxies like this one may actually be the stripped remnants of larger galaxies that were torn apart during collisions with other galaxies.

In other research, Strader continues to look for smaller black holes inside of globular star clusters.

"We are finding new black holes in many of these clusters. So it seems like these really small black holes are common in globular clusters; it's not a rare occurrence, as previously thought," Strader said. "It is expected that these will be good sources of gravitational waves."

"Scientists think that within the next few years we may be on the cusp of the first detection of gravitational waves—which is the ultimate test of Einstein's theory of relativity. And it could be that these black hole sources in globular clusters could provide the first signal." 🌌

Cool research: Searching for neutrinos at the South Pole

When Tyce DeYoung plans his next research field trip, he'll make sure to pack his mittens, scarf and long underwear.

The MSU associate professor of physics and astronomy (PA), along with PA assistant professor Kendall Mahn, is part of an MSU team that recently joined an international consortium studying mysterious particles known as neutrinos.

The site of the lab where they do the work: The South Pole.

The consortium consists of 300 researchers from 12 countries. It is named, very appropriately, the IceCube Neutrino Observatory.

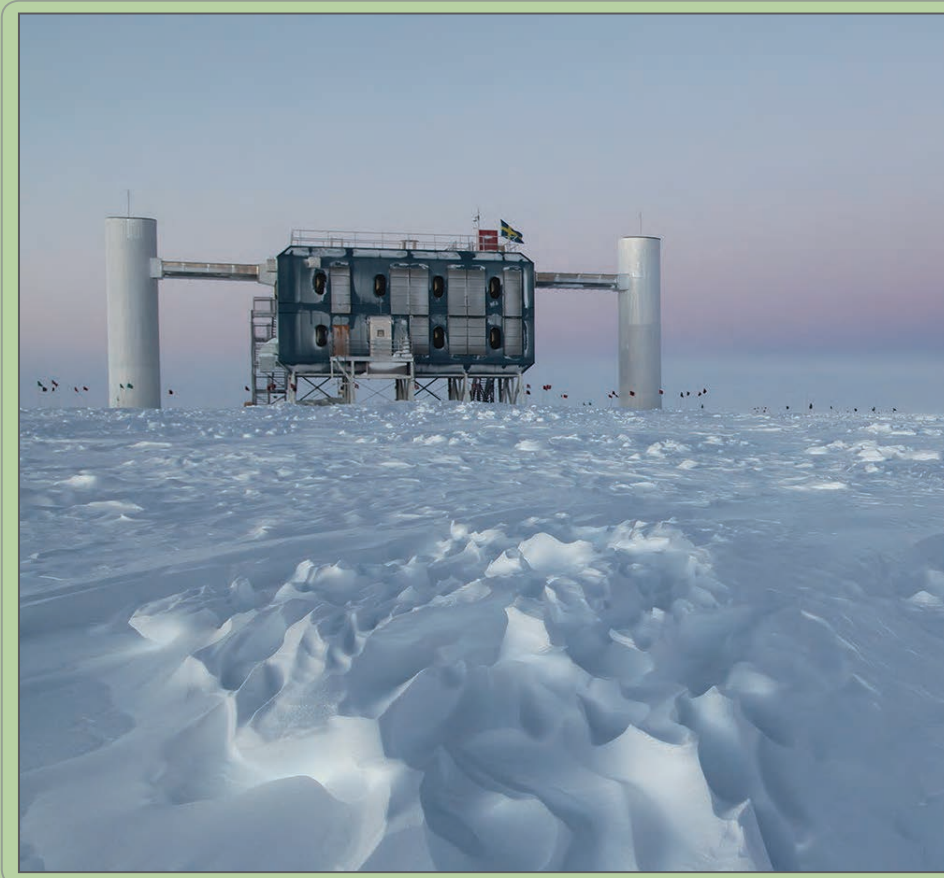
"Neutrinos are fundamental particles, like electrons or the quarks that make up protons," De Young said. "They are one of the by-products of stellar events such as supernovas."

The researchers do their work at the South Pole because it is a "clean lab," ideally suited for gathering the particles as they bombard the Earth.

"South Pole ice is cleaner than any ice you could make in a lab," DeYoung said. "It is incredibly transparent and nearly free of radioactive contaminants."

This is important, he said, because they use the ice as the medium to observe the neutrinos.

When neutrinos collide with protons that are already in the ice, they produce



The South Pole is the location of the aptly named IceCube Neutrino Observatory. MSU recently joined the international consortium that studies neutrinos, fundamental particles that are produced by stellar events such as supernovas

"They give off a shock wave, just like a plane moving faster than the speed of sound," DeYoung said. "But instead of a sonic boom, it's a visual equivalent of that. Light is produced and it's that light we detect."

The light is detected by instruments known as digital optical modules that are located several thousand feet beneath the surface of Antarctica.

"We are able to create neutrinos at accelerators such as Fermilab," DeYoung said. "But we

can measure some things much less expensively using free-range, organic neutrinos.

"Neutrinos are harmless," he added. "It's estimated that trillions of them pass through us every second."

DeYoung said the work he and his colleagues do is strictly basic research. But he said that all major discoveries have their roots in basic research.

"If you look back over the last century, there are countless examples of things that were so exotic when they were first observed," he said. "The better we understand nature at a fundamental level, the more ability we have to build a society that provides for its citizens."

For more information about the IceCube collaborative, visit icecube.wisc.edu.

"The better we understand nature at a fundamental level, the more ability we have to build a society that provides for its citizens."

a spray of particles with so much energy that they actually outrun light in the ice.

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Planetarium celebrates 50 years of stargazing, new director

In 1964, the “Space Race” was heating up, men and women were traveling to outer space, and amazing photos of the moon, planets and stars were being taken. That’s when the MSU Abrams Planetarium first opened for business. Since then, hundreds of thousands of school children and visitors have learned about constellations, planets, stars, galaxies, black holes and many other astronomical wonders at the planetarium. MSU faculty members have also used the facility for teaching classes, and it has been the site of university social events.

This year the planetarium marks its 50th anniversary with the installation of a new star projector and the welcoming of a new director, Shannon Schmoll, who received her Ph.D. in astronomy and education from the University of Michigan in 2013.

The new projection system features digital video projection that covers the entire dome of the planetarium, a big step forward in technology. However, the mission of Abrams remains the same as it was a half-century ago.

“We strive to increase the appreciation and awareness of the night sky and support science literacy for everyone,” said Schmoll, who has been charged with expanding the



Shannon Schmoll is the new director of the MSU Abrams Planetarium.

planetarium’s reach on campus and in the community. “We do this through full-dome shows with live presentations, engaging interactive multimedia and tailored programming for K-12 students, as well as providing a venue for undergraduate education across disciplines and collaborating with people across campus and the community.”

The planetarium is named in honor of Talbert “Ted” and Leota Abrams who in the 1960s contributed to MSU to build a space science education center. Ted Abrams was a leader in the field of aerial photography.

For more information on Abrams Planetarium and its public shows, visit www.pa.msu.edu/abrams. 