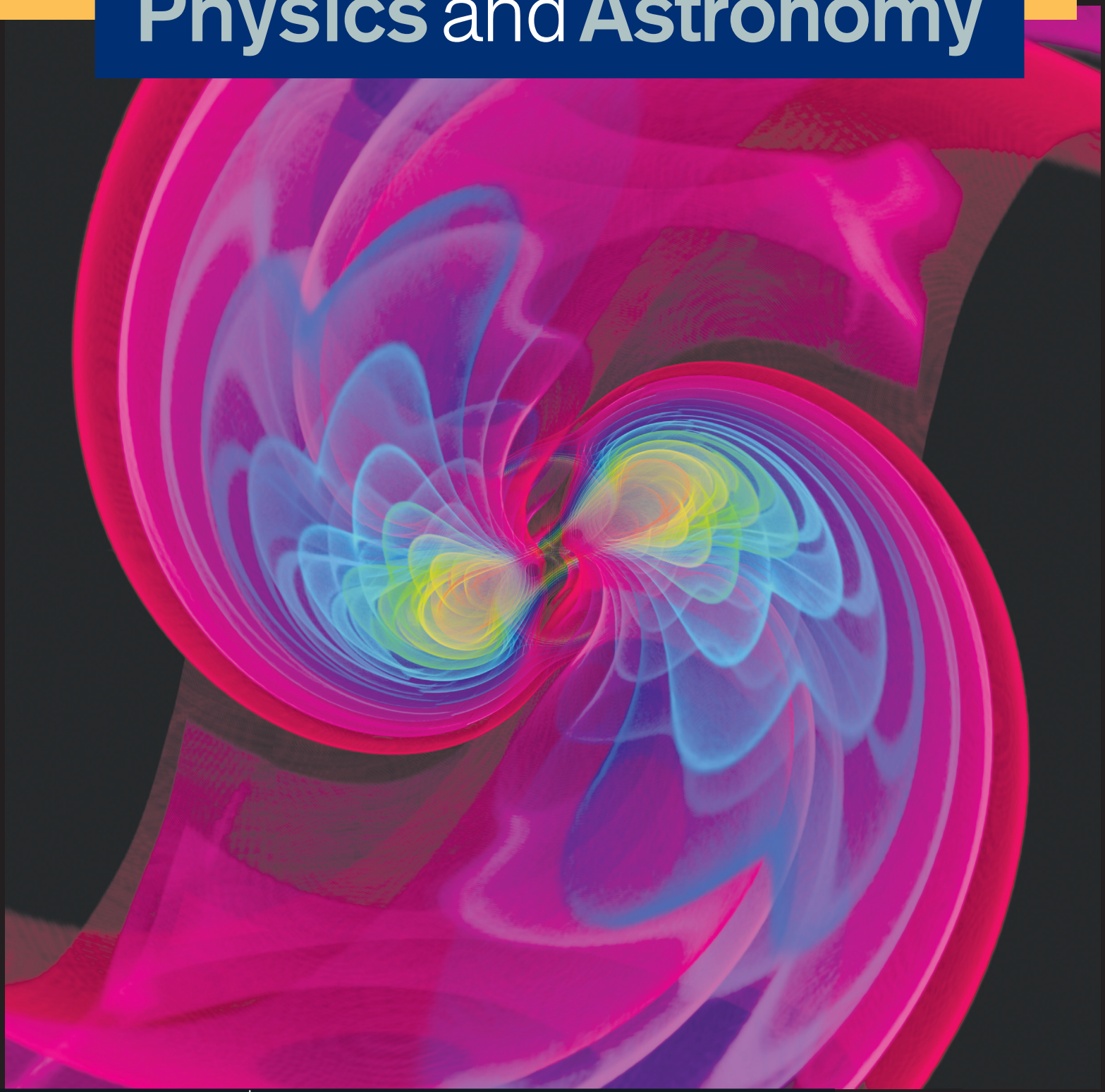
Annual Magazine
ISSUE 17

UNIVERSITY OF MINNESOTA

SCHOOL OF Physics and Astronomy



Gravitational Waves

LIGO proves the existence of gravitational waves and binary black holes.

School Head
RONALD POLING

A letter from the Head of the School

The big news for the School of Physics and Astronomy in 2016 is the Tate renovation project. We are more than halfway through construction, which is scheduled to finish in July 2017. While there is still a long way to go, some of the terrific features of the new Tate are now taking shape, including the beautiful six-story atrium. Much of the work on the exterior façade of Tate is complete, with about half of the reconditioned windows installed and most stonework restored. The building will be ready for winter construction with the installation of the atrium skylights in October. The School's students, faculty and staff look forward with great excitement to our return to Tate, especially those who have had their offices and teaching scattered across campus into "swing space."

2016 has been a great year for science overall and for the School's research in particular. The highlight has unquestionably been the first direct detection of gravitational waves by the LIGO detectors, opening a new window on astrophysical phenomena like merging black holes. Vuk Mandic and his group are leaders in the LIGO science program. More than thirty years of physics research at the Soudan Underground Laboratory in Tower, Minnesota has drawn to a close. The pioneering experiments at Soudan helped shape modern elementary particle physics, and the University and the state of Minnesota have made crucial contributions. Research continues with the beam that was built at Fermilab, near Chicago, to send neutrinos to northern Minnesota. NOvA, with its Far Detector in Ash River, is one of the world's leading neutrino experiments. Our group, led by Marvin Marshak, is employing NOvA expertise and facilities in the design of DUNE, a future experiment that will use a new neutrino beam from Fermilab to South Dakota.

Many members of the School have earned recognition during the past year for excellence in research, education and service. Decades of seminal contributions to theoretical particle physics were recognized this summer by the award of the Dirac Prize of the International Center for Theoretical Physics to Misha Shifman and Arkady Vainshtein. Jim Kakalios received the American Institute of Physics Gemant Award for contributions to the popular understanding of physics. Among our outstanding young faculty members, Rafael Fernandes has been named a Cottrell Scholar and Vlad Pribiag received an NSF CAREER Award. Our Society of Physics Students group was again named an Outstanding Chapter and received the Marsh White Physics Outreach Award. Other recognition, including four faculty members awarded APS and AAAS Fellowship, are documented on the School's web site (www.physics.umn.edu), where you can also find announcements of upcoming events. I hope that many of you can join us for the next Abigail and John Van Vleck Lecture, which will be presented on April 19, 2017 by Professor Arthur McDonald of Queen's University. Professor McDonald is one of two recipients of the 2015 Nobel Prize in Physics, recognizing his leadership of the Sudbury Neutrino Laboratory in Canada, which made critically important contributions to the discovery of neutrino oscillations.

In closing I would like to note a transition in the leadership of the College of Science and Engineering. Steven L. Crouch served as dean for more than a decade, and during his tenure the college has thrived in every way. Undergraduate applications have hit all-time highs and each year's freshman and transfer classes have been better prepared and more diverse. The size of the CSE student body has grown by 20% and the college has added more than 40 new professors. Exciting research programs have been launched and state-of-the art facilities have been built or renovated, including our own Physics and Nanotechnology Building and Tate Hall. Steve's support of the School has been extraordinary, and I am deeply grateful for the outstanding example that he has set as an academic leader. Our new dean, Samuel B. Mukasa, joined us on August 31, 2016. Dean Mukasa is a geochemist who was previously dean of the College of Engineering and Physical Sciences at the University of New Hampshire. We look forward to working with him in the years to come to raise CSE and SPA to even greater success.

Thanks very much for your support of and interest in the School of Physics and Astronomy.

Please send class notes, comments and mailing list changes to:
Jenny Allan or Julie Murphy
School of Physics and Astronomy
University of Minnesota
115 Union Street S.E.
Minneapolis, MN 55455
alumni@physics.umn.edu
Ronald Poling, Head, School of Physics & Astronomy
Julie Murphy, Managing Editor
Jenny Allan, Editor

SCHOOL NEWS

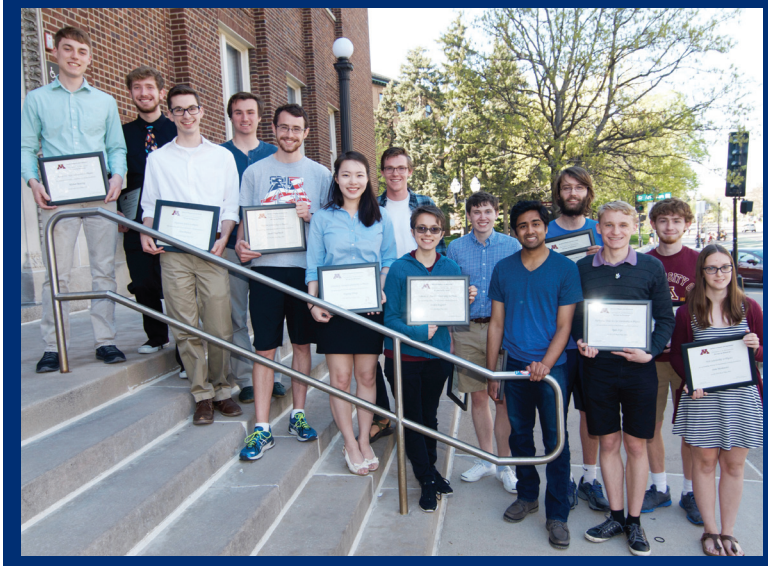
Shifman and Vainshtein win Dirac Medal

Professors Mikhail Shifman and Arkady Vainshtein were awarded the International Center for Theoretical Physics (ICTP) 2016 Dirac Medal and Prize in Theoretical Physics. They were cited for their "contributions to a better understanding of field theories in the non-perturbative regime and in particular for exact results in supersymmetric field theories." The award citation described Shifman and Vainshtein's collaboration, which began more than 40 years ago in Moscow, as one of the most fruitful in theoretical physics. "Among a variety of work on strongly interacting field theories, they introduced use of the gluon condensate (a property of the vacuum in QCD) and developed the Shifman-Vainshtein-Zakharov (SVZ) sum rules. The SVZ sum rules relate observed properties of hadrons to the gluon condensate and a few other condensates.

Zooniverse takes on Civil War project

Lucy Fortson, co-founder of Zooniverse and Associate Head of the School, has helped develop a crowdsourcing technology to spark curiosity and develop critical thinking skills among students. The latest project will be to transcribe and decipher nearly 16,000 Civil War telegrams between Abraham Lincoln, his Cabinet, and officers of the Union Army. Roughly one-third of the messages were written in code. The University of Minnesota is part of a national effort in innovative crowd sourcing led by The Huntington Library, Art Collections, and Botanical Gardens to gain new insights into the U.S. Civil War. The Decoding the Civil War Project, was built and is managed by the University through Zooniverse, the largest online platform for collaborative volunteer research. "The Decoding the Civil War project is an exciting example of a historical research project enabled by the crowdsourcing capabilities of the Zooniverse platform and the Zooniverse team at the University of Minnesota," said Fortson.

2016 Undergraduate Scholarship Recipients



Front row: Chris Phenicie, Jacob Freyermuth, Jingyang Zheng, Kendra Bergstedt, Vikram Nagarajan, Ryan Vogt, Irene Moskowitz

Second row: Michael Revering, Erik Husby, Jack Lange, Ben Sharkey, Ryan Schmitz, Aaron Hamann

Jeffrey Basford Scholarship for Undergraduate Research: Jacob Freyermuth and Ryan Schmitz
J. Morris Blair Scholarship: Jack Lange and Ryan Schmitz
Edmond B. Franklin Scholarships: Kendra Bergstedt, Melissa Bosch, Jingnan Cai, Aaron Hamann, Adam Hines, Elliott Imhoff, Jack Lange, Richard Spieker, Jingyang Zheng, and Andrew Ziegler
The Hagstrum Award: Kyle Crocker and Chris Phenicie
The Holt Scholarship in Physics: Irene Moskowitz
The LaVerne and Ted Jones Scholarship in Astrophysics: Ben Sharkey and Erik Husby
The A. O. C. Nier Undergraduate Scholarship in Physics: Vikram Nagarajan and Michael Revering
The Oswald Scholarship in Physics: Aaron Hamann
Harry and Viola St. Cyr Scholarship for Undergraduate Research: Ryan Vogt
Swanson Scholarship in Astrophysics: Arpit Arora, Lukas Wiedman and Alexander Igl

SCHOOL NEWS

Fernandes named Cottrell Scholar

Professor Rafael Fernandes has been named a 2016 Cottrell Scholar by the Research Corporation for Science Advancement (RCSA). The award comes with $100,000 to be used in research and teaching. Fernandes was one of 24 recipients in the fields of chemistry, physics and science. He was cited for his research, "A Tale of Two States: Interplay Between Magnetism and Superconductivity in Quantum Materials."

Greven named AAAS Fellow

Professor Martin Greven has been named a Fellow of the American Association for the Advancement of Science. He was elected in the Section on Physics for establishing a stellar record in growth and perfection of high quality crystals of oxide superconductors, enabling experiments leading to important advances in the field. Greven was one of four University faculty elected fellows this year.

Hanany receives Taylor Award

Professor Shaul Hanany has received the 2016 George W. Taylor Distinguished Teaching Award. He was recognized for his exceptional contributions to undergraduate education, teaching and mentoring. The honor comes with $3,000 to be used in professional development.

Kakalios receives Gemant Award

Professor James Kakalios won the 2016 American Institute of Physics Gemant Award. He was recognized for his contributions to the popular understanding of physics. He is the author of "The Physics of Superheroes" and "The Amazing Story of Quantum Mechanics." The award includes a $5,000 prize and $3,000 to further the public communication of physics at an institution of the winner's choice. Kakalios named as a recipient of the grant Franklin Middle School in Richfield, MN.

Pribiag receives Career award

Professor Vlad Pribiag has received an National Science Foundation (NSF) Faculty Early Development (CAREER) Award. The award which amounts to more than $642,000 for a period of five years was given for his research in "Backscattering, Confinement and Superconductivity in a Two-Dimensional Topological Insulator.

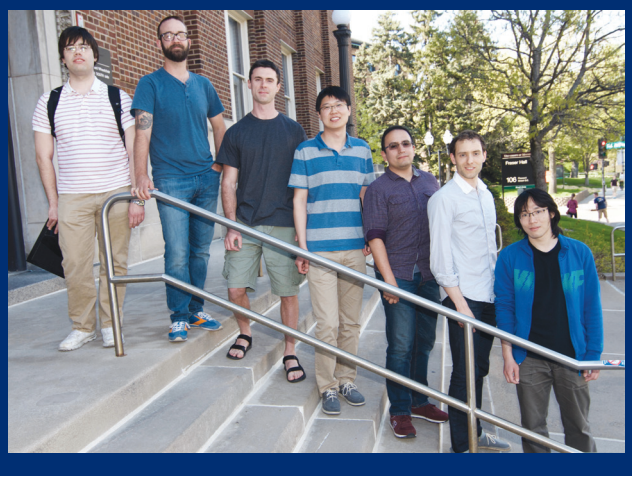
Perkins, Pryke and Wygant named APS Fellows

Professor Natalia Perkins was named an fell of the American Physical Society "for theoretical studies of the low-energy behavior of strongly correlated electron systems that exhibit an interplay of orbital and spin degrees of freedom."

Professor Clement Pryke was named for "groundbreaking measurement and data analyses of the polarization of cosmic microwave background radiation, and for providing strong constraints on the composition and initial conditions of the early universe."

Professor John Wygant was named for "advancing our understanding of energy flows by Alfvén waves and particle acceleration in regions of magnetic reconnection and collisionless shocks and the design; and implementation of the space-borne instruments used in these studies."

2016 Graduate Fellowship Recipients



Leonard F. Burlaga Fellowship: Sheng Tian
Allen Goldman: Ryan Marshall
Robert E. Grieling: Karl Young and Ruiqi Xing
Anatoly Larkin Fellowship: Jiaming Zheng
Hoff Lu Fellowship: Ming Li
Robert O. Pepin Fellowship: Justin Willmert and Evgeniy Kurianovych
Aneesur Rahmen Prize: Tao Qu, Tobias Gulden and Qianhui Shi
Outstanding TA Awards: Siddarth Karuka, Alex Papageorgiou, Alexey Zinger, Marcos Garcia Garcia, Andrew Miller, Hannah Rogers and Jeff Chaffin (Undergrad)

From left to right: Evgeniy Kurianovych, Jeff Chaffin, Alexey Zinger, Sheng Tian, Marcos Garcia Garcia, Andrew Miller and Jiaming Zheng

3M gift allows Physics Force to expand beyond Twin Cities

A $10,000 donation to the Physics Force will allow the group to extend their reach beyond the Twin Cities. Physics Force's main activity in recent years has been to perform a week of shows at Northrop Auditorium for school-age kids and families from the metro area. About 25,000 spectators have experienced the shows annually during that one week.

The donation will fund a series of shows in May 2017 in Rochester's Mayo Civic Center.

While this is not the first time Physics Force has performed out state, it is the first time the team will deploy its entire 'Physics Circus' Program that includes the most spectacular demonstrations. And if the donation continues annually, so will the Rochester shows. Physics Force member, Professor Shaul Hanany said that the gift "gives us the opportunity to broaden our reach and fulfill our mission more effectively."

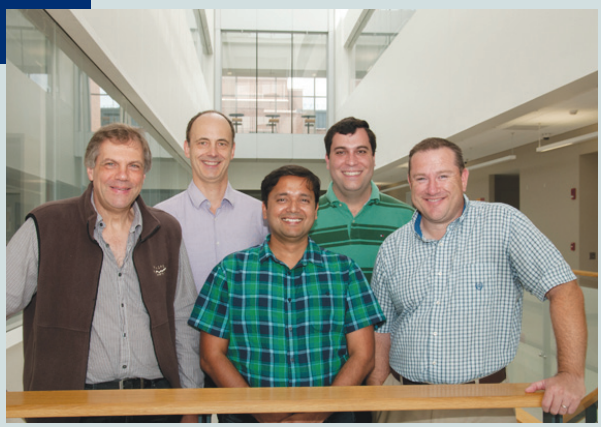
The Physics Force is hoping to further strengthen its ties with 3M and other partners. 3M employees and their families will receive preferred seating during the Winter shows and the Force is exploring visiting and performing a show at 3M.

New Center for Quantum Materials

The new Center for Quantum Materials (CQM) at the University, supported through an initial three-year $2.6 million grant by the U.S. Department of Energy, will bring together three experimental researchers and two theoretical physicists to tackle problems in a family of materials called complex oxides. Answering fundamental questions about these materials could significantly impact technological progress.

One of these outstanding questions is the mechanism of high-temperature superconductivity. A superconductor is a metal that manages to attain zero electrical resistance and to expel magnetic field from its interior below a certain temperature. Conventional superconducting devices have a vast array of technological applications that range from magnetic resonance imaging (MRI) machines to the power industry. When this phenomenon was discovered in the copper oxides in the 1980s, it was generally thought that the goal of creating a room-temperature superconducting device was within reach. Scientists have been able to refine the copper oxides to work up to a temperature of 135 K (-217 F). Although these high-temperature superconductors have found some real-world applications, they are still a long way from zero resistance and hence zero energy waste at room temperature. A major reason for this is that scientists still do not fully understand the mechanism that causes this phenomenon, despite one of the largest research efforts in the history of science, with more than 200,000 research papers published on the topic.

Challenging scientific problems involving complex oxides extend well beyond high-temperature superconductivity and include many fundamental questions pertaining to the quantum behavior of interacting electrons. Complex oxides are of relevance to technologies such as data storage, spintronics, sensing, catalysis and fuel cells. The goal of the new Center is to raise the understanding of the myriad phases exhibited by these materials that have proved so challenging in the past.



CQM faculty Andrey Chubukov, Martin Greven, Bharat Jalan, Rafael Fernandes, and Chris Leighton

Significant advancement in this area requires a focused, interdisciplinary approach, and the CQM will bring together five UMN faculty members, about a dozen Ph.D. students and postdocs, as well as a large network of collaborators. The five highly productive scientists include two theoretical physicists (Andrey Chubukov and Rafael Fernandes), an experimental physicist (Martin Greven), and two experimentalists from the Department of Chemical Engineering and Materials Science (Bharat Jalan and Chris Leighton). The experimentalists are among the world's leading experts in the growth and study of highly specialized thin films and bulk crystals of complex oxides. The hope is that the formation of the Center will serve as a steppingstone toward establishing the University as a world-leader in quantum materials research.

Gravitational Waves Found!

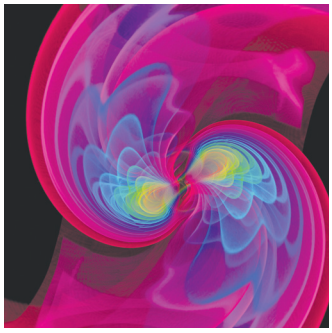
AND BINARY BLACK HOLES CONFIRMED

U researchers play key role in double discovery

The discovery of gravitational waves, and with it, the confirmation of binary black holes—made headlines around the world this year. A second observation made three months later by LIGO helped to solidify the discovery with data that complemented what was learned from the first event. Professor Vuk Mandic and his research group played an important part in these breakthroughs and are continuing to build the next generation of gravitational wave detectors.

"The observed events are not only the first direct detection of gravitational waves, confirming Einstein's Theory of General Relativity. They also confirm that stellar-mass black holes exist, that they can live in pairs (binaries), and that the binaries lead a dynamic life potentially merging during the lifetime of the Universe," Mandic said. Mandic has been a part of the LIGO collaboration since he joined the School in 2007.

Part of the importance of the discovery of gravitational waves lies in their usefulness as an observational tool. Gravitational waves carry information about their dramatic origins and about the nature of gravity that cannot otherwise be obtained. Mandic is one of the leads of a companion paper describing the implications of the observed gravitational waves event.



About the cover image: A simulation showing two black holes of 29 and 36 solar masses, which dance around each other and will merge in a few moments. They emit a gravitational waves which were observed in LIGO detectors.

Courtesy of numeric-relativistic simulations: S. Ossokine, A. Buonanno (Max Planck Institute for Gravitational Physics)/Scientific visualization: W. Benger (Airborne Mapping Hydro GmbH).

Based on the observed signals, LIGO scientists estimate that the black holes for this event were about 29 and 36 times the mass of the sun, and the event took place 1.3 billion years ago. By looking at the time of arrival of the signals—the detector in Livingston, LA recorded the event seven milliseconds before the detector in Richland, WA—scientists can say that the source was located in the southern hemisphere.

According to general relativity, a pair of black holes orbiting around each other lose energy through the emission of gravitational waves, causing them to gradually approach each other over billions of years, and then much more quickly in the final minutes. During the final fraction of a second in the observed event, the two black holes collide into each other at nearly one-half the speed of light and form a single more massive black hole, emitting gravitational waves of energy equivalent to three times the mass of the sun. The peak power output was estimated to be about 50 times that of the entire visible universe.

This may be only the beginning. Gravitational waves are expected to open a new window onto the universe, providing information about many phenomena including the Big Bang itself.

"For every observed binary black hole merger, there are many more that are too distant and too faint to be directly observed," postdoctoral researcher Gwynne Crowder said.

These mergers add up to make a 'noise' of gravitational waves, similar to the noisy surface of water in a pond. This noise is also potentially detectable by researchers. Such a detection would probe a very distant part of the population of black hole binaries and it would inform us about the evolution of these binaries and of the observed structure in the universe.

With the NSF funding support, the Minnesota group has led a series of data analysis projects searching for gravitational

> **The wealth of information extracted from the observed binary black hole merger is indicative of the scientific potential of gravitational wave observations, and it motivates us to look forward to future gravitational wave detectors**
>
> Vuk Mandic

waves in LIGO data, as well as detector characterization studies aimed at understanding and improving the performance of LIGO detectors and of their response to gravitational waves. The group's work led to multiple publications in Nature, Physical Review Letters, and other leading physics journals.

Developing the next generation of gravitational wave detectors with improved sensitivity requires addressing a number of technical obstacles, including the noise limitations induced by seismic motion of the ground near the detectors.

To this end, the Minnesota group is leading an interdisciplinary NSF-funded project with a group of geophysicists, aiming to study the behavior of seismic waves underground. The group has developed a unique three-dimensional array of seismometers at the Homestake mine in Lead, SD, which is now collecting data.

"The Homestake data will allow us to study the composition and the origin of seismic waves at different depths, hence informing the design of potential future underground gravitational-wave detectors," Mandic said.

Photo by Richard Anderson

From left to right: Patrick Meyers, Andrew Matas, Rich Ormiston, Sharan Banagiri, Vuk Mandic, Levi Walls, Margot Fitz Axen.

STUDENTS BUILDING SATELLITES

Lindsay Glesener is a new faculty member in space physics, specializing in high energy events in the sun. Glesener uses X-rays to observe solar flares and coronal mass ejections. These events throw plasma and radiation into space, causing the Earth's aurorae and causing high radiation environments in Earth's orbit, adversely affecting spacecraft. Glesener studies this topic from a fundamental physics perspective, trying to answer remaining questions about how these solar events are energized and the high-energy nature of the sun.

Physicists do not understand why the sun's outermost layer, the corona, is so much hotter than the surface of the sun, how the particles that are ejected get accelerated in the first place or how energy transfer happens at such a high rate. It has been theorized that the solar flares are triggered by release of energy from the sun's magnetic fields, which occasionally become stressed and "reconnect" to a much lower energy level. This dumps huge amounts of energy into the corona, causing particles to move at relativistic speeds. There is a great deal of energy transferred in this process, up to half the energy released in a solar flare, which is unusually high. There have been some proposed answers to this mystery, such as shock acceleration, turbulence, and contracting magnetic fields. Glesener is trying to help narrow down the search. "We have a wealth of data, but there are still a lot of things we don't understand very well. So we've decided we need even better data than what we already have."

To get better data, Glesener is part of several analysis projects, as well as researching new instrumentation and new technologies. "The end goal of a lot of that instrument development is to try to get a new spacecraft, but you can't just go to NASA and ask for $200 million. They're going to ask you a lot of questions about what's your concept, what proof do you have that everything will work so that we know that everything is tested and tried." Intermediary testing steps include trying out technology in the lab, and using sounding rockets--relatively small rockets -- that fly a payload into space. Sounding rockets do not go fast enough or high enough to go into orbit or to escape the Earth's gravity. A sounding rocket boosts a payload up into space, where it stays for a short while before falling back to Earth, almost in the same spot

Lindsay Glesener (right) with her student Kendra Bersgtedt.

from which it was launched. With a sounding rocket you get into space for a total observation time of six minutes. "It's quite exciting and dramatic because you spend a few years building this, and then you fly it and you have six minutes to do your thing. So you really have to make sure everything works." She says that physicists usually recover the payload in good condition from these test flights, which is another advantage. "You get to take it back to your lab and assess everything, make sure everything's healthy, do some more calibrations." Sounding rockets are not just useful for testing. Glesener, says real science can be done, even in six minutes.

Glesener is also involved with designing CubeSats, which are a type of spacecraft that are about the size of a shoebox and weigh only a few kilograms. She has NASA and Air Force funding for this project which is a collaboration between the School and the Department of Aerospace Engineering. These CubeSats will carry instrumentation to study high-energy solar flares. They are typically taken up to the Space Station with supply shipments and launched from the Station's CubeSat launcher, or else taken as "piggyback" payloads on launches for larger spacecraft. She says that in the past these small craft were only used for student training or to test instrumentation, but scientists are now building and flying CubeSats that stay up a year or more and make useful scientific measurements. "For students this is a really great opportunity. At some point, before they graduate, they will be able to say, 'I built this payload that went into space.'"

MODELING COSMIC VIOLENCE

Tom Jones says that if there's an overarching theme to his research it's cosmic violence: black holes, supernovas, quasars and now, the collisions between clusters of galaxies. These collisions are the most extreme thing he's ever studied in decades of research. "They are the biggest bound, held-together structures in the Universe."

Jones builds computer models of the collisions in order to help astronomers who are observing the real thing. What observers see of these events is messy. His work is to look for patterns that can help them make sense of what they are seeing. "Can we figure out what should happen, so that when an astronomer looks at this messy event, they can tell what's going on? We want them to be able to use this as a diagnostic of the event."

Individual cluster collisions can last a billion years, and they have been fairly common cosmic events for several billion years. Astronomers sample events over time, since the more distant events we see today actually took place some time ago. This makes them useful for cosmologists trying to piece together a picture of developments during that period in the Universe. In this way, observations of clusters of galaxies are a time machine, in that the light has taken up to several billion years to reach Earth. In addition to the full cluster simulations, Jones also simulates what happens when powerful jets of gas from black holes at the centers of galaxies plow into the gas spread throughout the clusters. The structures that form, which are very common, are called radio galaxies He hopes to identify patterns in the properties of the radio galaxies that can reveal important, but hard-to-see behaviors in the colliding clusters.

Jones admits it can be difficult to grasp the scale of the events he studies. He regularly runs computer simulations in a few hours for events that took 100s of millions of years to occur. One of the biggest challenges is to translate the size of the structures into something you can visualize. "Our solar system, in comparison to the size of these clusters, it's so tiny. It's smaller than a microbe is in comparison to a human being."

The simulations will also tell astrophysicists a lot about working with matter on a very vast scale and at very high temperature. The interstellar media becomes very hot, approaching 100 million degrees, and yet the densities are very low. "Everything is ionized, the atoms are all stripped apart, and the distances that one of these stripped apart nuclei or electrons travel before they bump into another is thousands of lightyears." Despite the sparseness, there are enough of these atoms that they, in a sense, communicate long range and work together. They appear to be in equilibrium and yet, taken on a "small" scale, (in Jones' world that means less than a thousand light years) they are not in equilibrium. There is a debate about whether these "small scale" effects matter to the whole process. Jones collaborates with space and plasma physicists who work with extreme temperatures on smaller scales, since they can directly measure things astronomers can only observe remotely.

Jones builds his simulations using community accepted constraints, consulting the latest interpretations of the Cosmic Microwave Background, for example. This information is fed into the simulation, along with insights from previous models and other observations. One outcome of his work has been to produce images that are facsimiles of light emissions from real, physical objects, and then to compare them to what astronomers are seeing in telescope data, especially when they obtain complicated data they don't understand. This has been particularly rewarding for studies of radio galaxies distorted by violent disturbances in their cluster homes. "These radio galaxy structures are exactly the sort of thing that Radio Galaxy Zoo, a novel astronomy crowdsource project, is looking for. They are going to find these really distorted radio galaxies. They're finding them and expect to find lots more of them." Not only will Jones' models help astronomers identify the cause of anomalies but obtaining further examples of those anomalies will help Jones build up his diagnostic tool kit by giving him more data to plug into his simulations.

Alumni Giving
FELLOWSHIP

CHARITABLE INVESTMENT IN THE SCHOOL OF PHYSICS AND ASTRONOMY:

Contributions Make a Difference


Shannon Weiher

The transformation of Tate Hall continues amaze. The complete renovation to the new home of the School of Physics and Astronomy and School of Earth Sciences is on track for summer 2017. You can following this impressive project on the Tate webcam at cse.umn.edu/r/tate-webcam, the view is of the new construction on Church Street. We continue to fundraise for the building project and welcome your support directed to fund 20517. [z.umn.edu/19c3]

A fund has also been established in memory of Homer Mantis (see obituary on page 19) to support travel for graduate students in physics. Contributions may be directed to the University of Minnesota Foundation, P.O. Box 860266, Minneapolis, MN 55486-0266. In the memo line, write "Homer T. Mantis Conference Travel Award. You may also give online: give.umn.edu/giveto/HomerMantis

Additionally, we are grateful to the many alumni and friends who continue to support our students and faculty. Contributions to scholarships, fellowships, faculty research, and the physics general fund enable the program to competitively recruit top graduate and undergraduate students to the university, provide materials and equipment used in teaching and student research, and create opportunities for research collaborations on campus and around the world.

When you receive a letter or a call from one of our students asking for your support, please consider doing so. Your support is instrumental to the department. If you have questions or need assistance in making a gift to the School of Physics and Astronomy, please contact me.

Shannon Weiher
External Relations
612.624.5543
seweiher@umn.edu
give.umn.edu

Why We Give: Michael Revering

Michael Revering is a senior physics major who spent last summer working on the Large Hadron Collider at CERN in Switzerland, thanks in part, to the Alfred O.C. Nier Scholarship. Revering created software for the Beam Halo Monitor, which keeps track of stray particles that escape from the accelerator ring. Revering wrote code that goes through the readouts from the detector and tie those with events where something went wrong, so that they can rapidly produce graphs to see what the background looked like for those events. The beam halo monitor helps physicists keep the experiment working efficiently. "You want to be able to see which beam injections didn't work right or if the magnets are off for the events you are looking at," Revering says. He also wrote firmware for the High Granularity Calorimeter test beam, part of a necessary upgrade in the experiment's ability to measure heat as the LHC will be powering up to higher energies in the coming years.

Revering says the Nier scholarship allowed him to make a choice for summer employment based on what he wanted to do in physics, rather than financial concerns. "It helps quite a bit. I can eat fancier cheese while I'm here. Being at the LHC is a great experience, but it doesn't pay as much as staying in town and getting a nice internship somewhere. The scholarship helps make up the difference."

IN MEMORIAM

Ronald S. Lazarus (M.S. 1965) 1940- 2016, of Sallisaw OK, formerly of Minneapolis, passed away February 28, 2016. Ronald graduated from North High in 1958 and received a master's degree in Physics from the University of Minnesota in 1965; he then went on to work for McDonnell Douglas Aerospace Co. He was preceded in death by his parents Maurice & Rose. Survived by children, Lee, Barry and Julie Lazarus; brothers, Bruce (Elaine) and Mickey (Carri); nieces and nephews.

James John MacKenzie (Ph.D. 1965) 1939 - 2016, of Gaithersburg, MD died on April 16, 2016 due to complications of Parkinson Disease and pneumonia. James was born in Cambridge, MA on December 24, 1939. He graduated from Boston College and earned his Ph.D. in Theoretical Nuclear Physics from the University of Minnesota. Before his retirement, James was a Senior Associate at the World Resources Institute in the Climate, Energy and Pollution Program in Washington, DC. Prior to that he was a co-founder and worked on the staff of the Union of Concerned Scientists, and he was a Senior Staff Member for Energy at President Carter"s Council on Environmental Quality. He authored and coauthored numerous books and studies on transportation, climate change, energy security, and other environmental issues. He had worked with Nobel prize winner Henry Kendall on issues such as nuclear reactor safety. He created beautiful black and white photographs, enjoyed woodworking, built and played musical instruments, and practiced and taught Aikido (a Japanese martial art). He was the beloved husband, father and grandfather of wife, Rhoda; sons, David (Bridgette) of Gaithersburg, MD, and Matthew (Dianne Cowan) of Cambridge, MA, and granddaughters, Gillian, Casey, and Jennifer. He is also survived by his sisters, Joan Fitzgerald and Mary MacKenzie; his brother, Kevin, and several nieces and nephews.

Karl Quisenberry (Ph.D. 1956) 1926 - 2016, of Asheville, NC died on February 18, 2016. Karl was born on April 4, 1926 in Washington, D.C. and served the U.S. Navy in the South Pacific during World War II. Following the war, he attended the University of Nebraska and later the Unviersity of Minnesota, where he received a Ph.D. in Nuclear Physics in1956. His professional life led him across the country, starting as a professor at the University of Pittsburgh, designing nuclear submarine reactors in Schenectady, NY and finally onto a career with Schlumberger in both Ridgefield, CT and Houston, TX. Karl moved to Asheville in 1993 and was active in numerous community groups including the Rotary Club, United Way and WCQS. In addition, he served on the Board of Directors of the Asheville Symphony Orchestra, where he was elected a Director Emeritus in 2007 in recognition of his outstanding service. Karl was passionate about travelling during his life, visiting 87 countries and all 50 states. In his younger years, he was an active hiker and skier (on both snow and water) and enjoyed flying a small airplane around the country. He is survived by Shirley, his wife of 67 years and their three children; Keith (and wife Karen) of Pittsburgh, PA, Nancy Brady (and husband David) of Woodbury, MN and David (and wife Jennifer) of Farmington, CT. In addition, Karl has five granddaughters, three grandsons and two grandpuppies.

Charles "Chuck" Reinert (Ph.D. 1969, MS., 1963, B.S., 1961) 1939-2016 of Tracy passed away Friday, May 6, 2016 at Sanford Tracy Hospital. Charles Peter Reinert, ND, Ph.D., CHt, EFT-ADV, BT P.I.T, was born May 23, 1939 in Tracy, MN. Early on, his passions included fascination with ham radios, helping his dad on the farm and beekeeping, and then playing the clarinet in the band. The passion for radios and tinkering developed into a college aptitude and a desire to quest for explanation to our universe and all of its mysteries, and ventured into physics. He graduated from the Unviersity of Minnesota with his B.S. in Physics in 1961 and his Masters in Science in 1963 and his Ph.D. in 1969. He took a position as physics professor at Southwest State University in Marshall, MN where he taught up until 1998 when he "retired." He also was a beekeeper by heritage and spent the summers training his children and community kids in the trade as well. Chuck always felt the pull to help and heal and could not stop himself from trying to find answers where modern medicine had not yet been. He got a Naturopathy degree and opened a Helping to Heal Clinic in 2003. He also spent his recent spare time (spare time was never much spent sitting except for a nap here and there!) entertaining nursing home residents and the like with his renewed love of music and singing. His family will forever have his voice and songs to remember him by. He is survived by his first wife, Judy Geegh, second wife Caryl Keith and third wife Lois Reinert and children Peter, Jennifer, Charly and stepchildren Michael, Michelle, Joseph and Nicholas.

Roald Wangsness (B.A. 1944) 1922- 2015, was born in Lac Qui Parle, MN. He worked at the U.S. Naval Ordinance Laboratory as a researcher in the 1950s before accepting a position as a Professor of Physics at the University of Arizona at Tucson, where he remained for most of his career until his retirement. He wrote a popular textbook, *Electromagnetic Fields* which is still in use today in its second edition. He was a fellow of the AAAS and on the advisory board for the American Journal of Physics.

CLASS NOTES

1961

Robert DuFault (B.S. Physics) seen here watching the Venus Transit in 2012. He is using his Tinsley 3" refractor, purchased in 1953.

Earle Kyle (B.S. Physics) I am in my 14th year as a NASA/JPL Solar System Ambassador helping inspire the next generation of space explorers. I hope some of these youngsters follow in my Apollo spaceship design footsteps and eventually put humans on Mars within my lifetime. My youngest son is now working at Blue Origin helping design commercial manned spaceships. I am looking forward to visiting him to see their facility later this year. I continue to work with gifted and talented middle school youth in the areas of college

1962

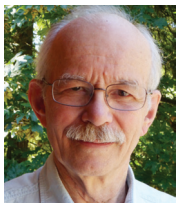
Richard D. Platte (B.S. Physics) I retired from full time work May. 2015, after fifty very fulfilling years in a national security career-- all except one in the field of intelligence. Those years went by swiftly, because I was fortunate to work with outstanding professionals in the government and industry, and able to stay focused on the important mission of gathering the highest priority strategic intelligence from potential adversaries.

1964

Richard F. Carlson (Ph.D. Nuclear Physics) I worked at UCLA (1964-1967) , University of Redlands (1964-2001) and did nuclear physics research at UCLA, Manitoba, Uppsala, Cape Town. I received my MA from Fuller Theological Seminary (1994). I am Currently active in the science-Christian faith research community. I have efereed publications in nuclear physics and Christian theology.

Dale E. Johnson (B.S. Physics) After 40 years teaching, doing research, and working in graduate administration in academia, I retired in 2014 and is currently living in Albuquerque, NM.

1966



Jim Mehl (Ph.D. Physics) Together with Joan, my spouse of 53 years, I live on an island off the shore of Washington State. I am still active in physics (electromagnetics, gas acoustics, quantum mechanics of gases), but take time to enjoy classical music and jazz, daily walks in the forest, and reading history and literature.

1967

Brendan Godfrey (B.S. Physics) I am living with my wife in the Houston area. I am partly retired, consulting with LBNL and on various IEEE committees, as well as on the National Research Council Panel, and the board of Ars Lyrica Houston.

1969

Lowell H. Rosen (B.S. Physics, M.S. Physics) Advisor was Prof. John Winckler. While in graduate school I was drafted and ended up in the Navy. I work on some of the first operational multi-computer systems. Continued on with the Center for Naval Analyses in Arlington VA, working in anti-submarine warfare. Currently involved in commercial flight safety with the MITRE Corporation. Married since 1972 with a son and two grandchildren.

1971

Everett H. Harvey Jr. (Ph.D. Physics) Living in Weaverville, CA in rural Trinity County. Retired from Lawrence Berkeley National Lab in 2005. I like to travel and I still read physics articles.

Steve Lindfors (B.S. Physics) In February 2016 my book was published. The title is: "A History of the Computer Industry--from Relay Computers to the IBM PC"

1972

Larry Backlund (B.S. Physics) I had the unique privilege to work on the Apollo program to the moon, as well as the F14 Fighter aircraft and other programs.

1973

Parke Kunkle (M.S. Physics) Recently retired after 46 years teaching physics and astronomy. Now supporting the new Bell Museum and Planetarium at the University.

1974

Keith L. Johansen (B. A. Physics) Also have an M.D. speicalizing in OB/GYN but continue to read physics and math at a level beyond my comprehension.

1975

Tom Demaree (B.S. Physics) I still am earning my living by flying an airplane. Totally enjoy studying atmospheric physics--but sometimes the fluid dynamics gets tough and I need help from a Ph.D. Remember, the vorticity of an irrotational flow is zero!

1981

James Babcock (Ph.D. Physics) My employers decided last year it was time for me to retire and they were right! Having a great time in San Diego biking, hiking, drinking wine, playing with cars, and going to the shooting club. I have also had the opportunity to fill in for staff in mechanical engineering at the University of California in La Jolla a couple of times. Enjoyed working with the students on their various senior projects, a bit reminiscent of grad school many years ago!

1987

Peter N. Steinmetz (B.S. Physics with honors) Established the Nakamoto Brain Research Institute (http://nakamotobri.org) to continue the analysis of publication of single neuron recordings we collected from the brains of epilepsy patients.

1988

John E. Barnes (Ph. D. Physics) After running the NOAA Mauna Loa Observatory in Hawaii for almost 20 years, I will be transitioning to work just on research. Most of my research involves atmospheric particles and I recently patented an instrument to measure their light-scattering properties.

Theodore Hodapp (Ph.D. Physics) Elected Fellow of the AAAS (APS Fellow in 2009). Finishing 12 years as Director of Education and

Diversity for the American Physical Society, and recently promoted to Director of Project Development.

1990
James W. Bergstrom (Ph.D. Astrophysics) I retired in 2014 from Ball Aerospace after 18 years of working on space-based Astrophysics and Earth/Planetary Science instruments. I am currently consulting as Systems Engineer for the HiRISE camera on Mars Reconnaissance Orbiter.

1990
Christopher White (Ph.D. Physics) Serving as Vice Provost for Academic Affairs at the Illinois Institute of Technology

1990
Jim Hetrick (Ph.D. HEP Theory, Y. Hosotani Advisor) After 15 years as Chair of Physics at the University of the Pacific, I have been appointed Assistant Director of the MS in Data Analytics program.

1991
Jim Engholm (B.S. Physics) Extending my career theme of being an analytical problem solver, I am now Vice President of Data Sciences for an small online wellness-program company called Novu in Saint Louis Park. Our primary focus is on helping Medicare and Medicaid populations, so it is very worthwhile work.

1993

Brian Neurauter (B.S. Astrophysics) Graphic designer/production artist. Currently composing an orchestral score for a short film. Picture: enjoying summer activities with wife Becky and children Linnea and Evan.

Rodney Olson (B.S. Astrophysics, B.S. Physics) I continue to teach high school physics and do NGSS work for the National and California Science Teachers Associations. I also became a NGSS test writer for the California Department of Education.

1994
Scott A. Anderson (B.S. Physics) I will begin grad school this fall at the University of Wisconsin - Madison in the Kinesiology Department.

1995
Sean Fain (B.S. Physics) Just completed my 14th year on faculty in the Medical Physics Department at University of Wisconsin. Full professor with tenure in 2014. All my best to Professor Kakalios who introduced me to Modern Physics and started me on this career path.

Debora Katz (Ph.D Astrophysics) The first edition of my calculus-based introductory physics textbook was published this past year, and it will be used this fall at U of M, Duluth!

1998
Bradford Hill (B.S. Physics) This summer I traveled to the White House to receive the Presidential Award for Excellence in Mathematics and Science Teaching from President Obama.

2002

Erika Grundstrom (B.S. Physics, B.S. Astrophysics) is a senior lecturer at Vanderbilt University in Nashville, TN. I am Director of Astronomy Labs and of Astronomy Outreach. I take the portable planetarium around the area. Classes are mostly for non-science majors (except one E&M classes). I also teach gifted high schoolers during part of the summer. My husband and I are expecting our first child!

Evan Goetzman (B.A. Physics) Wrote and performed musically for a few years, traveled often, then started my career downtown. Founded an engineering and consulting firm four years ago, where I work currently as software architect.

2005
Jacob Haqq-Misra (B.S. Astrophysics) My wife Gina and I recently purchased and renovated a rural property in Clayton, DE. I work from my home office as the Chief Operating Officer of Blue Marble Space.

2006
Vanessa Krake (B.S. Physics) I specialize in a branch of applied physics called 'Analytical'- physical characterization and analysis for product research and development. It is not particularly glorious but at times can be like living in "CSI: Industrial America". Recently I made a (working) trip to CharFac, which carried a strong sense of de ja vu since I spent a fair amount of time there on undergraduate research. Currently I am studying the art of puppy maintenance.

Erkan Tuzel (Ph.D. Physics) I got promoted to Associate Professor with tenure at Worcester Polytechnic Institute, Department of Physics in July, 2015.

2013
Ian Young (B.S. Physics) As of June 2015, I now work as an engineering physicist at Fermi National Accelerator Laboratory. I design and implement process control systems for large and small cryogenic processes that allow high energy physics research to be done! It's a great place to work and I could not have started here without working on the NOvA project at the U of M!

Steven Dorsher (Master of Science) It was a joy to celebrate my colleagues' success at the LIGO Livingston detector twice this spring. I am not an author on either gravitational-wave detection paper, but I feel grateful to be a member of the numerical relativity community and to again be a member of the LIGO collaboration.

Michael Rush (B.S. Physics) I am moving to Boulder, CO in August to begin a graduate program in the Department of Environmental Engineering - Hydrology and Water Resources. I will be working on a Ph.D. in biogeochemical modeling.

2016
Henry Duran III (B.S. Physics) Have gone over to the dark side: attending University of Pittsburgh for a degree in Mathematics.

Jett Priewe (Astrophysics B.S.) Attending UMN doctoral program for Astrophysics.

Kelly at CERN as an undergrad. Stifter is currently a graduate student at UC-Berkeley.

KELLY STIFTER

What helped you decide to come to the University of Minnesota for your education? Honestly, it was the price. I came from a middle-class family, and knew I would be paying any college costs on my own. I applied to several other schools, and when I got my financial aid packages back, I couldn't believe how much they expected me to pay. The University of Minnesota was much more affordable, and I am proud to say that I graduated debt-free. After my first year, I realized I was getting an Ivy-league class education for a fraction of the Ivy-league price, and knew I had made the right decision.

Who were your favorite professors? Though she never actually taught one of my classes, Professor Lucy Fortson had a significant impact on my undergraduate education. I worked as a T.A. in the physics department for five semesters, and I worked for her during two of those. During that time, I learned a lot about teaching physics, how to run an effective team, and what it means to be a leader. I went to her for a lot of advice over the course of my undergraduate education, and she never steered me wrong. Another favorite professor of mine was Dan Hennessy. The classes he taught were always very engaging, and I enjoyed them very much. Everyone in the class liked him. The classes were difficult, but not to the point of being demoralizing. He was genuinely interested in his students' success, and was always helpful.

What were your favorite classes? My very favorite class was Methods of Experimental Physics II (MXPII). In this class, we were required to design, build, and operate our own research project. It was in this class that I truly discovered my love for experimental physics. It was the first chance that I got to build up a system of hardware on my own where the data that came out told me some truth about the physical world. I also enjoyed Introduction to Particle Physics. This class served as a first taste of the complex and intriguing theory that lies behind our current understanding of how the world works. To see fundamental particles that make up much of the universe simply fall out of mathematical equations is mind-blowing.

Who was your adviser? My advisor was Professor Roger Rusack. I met him for the first time on my first day of college. He taught my thermodynamics class. I enjoyed the class, and often went to office hours. When it came time to choose an MXPII project, my partner and I asked him to be our advisor. He worked with us to get us started and build our set-up. I learned a truly immense amount from him during that process. During the summer before my senior year, I was sitting down with him to ask advice about which graduate schools I should apply to. I told him that I was interesting in building detectors. He sat and thought for a moment, and then told me that he had a project he would like me to work on that he thought I would really like. Then it happened - he asked me if I wanted to go to CERN! This was what I had been working towards my whole undergrad education, but I thought that I would not get the chance to go until graduate school. Naturally, I jumped at the chance. So during the second half of my senior year, I spent six months at CERN, working on a project that would become my undergraduate thesis project. I am so thankful to have had an advisor like Roger. He gave me an amazing opportunity that helped me stretch my skills and abilities in a way I did not even know was possible. His belief in me has helped me get to where I am today.

What were some of your favorite memories of your time while you were here? My favorite memory goes back to MXPII. One Friday night, my partner and I were still working in the lab at about 10 p.m. Out of all the things two college kids could be doing on a Friday night, we were still in lab. After struggling for nearly half the day with our experiment, we started to see the light at the end of the tunnel. All of a sudden, we saw the first oscilloscope signal which indicated that we had detected our first muon. What a feeling! To know that I could detect these fundamental particles using this technology that had been sitting around in the basement of the physics building for years... it made me realized for sure that I wanted to be a physicist. On a less academic note, my roommates and I had a very nice tradition: Nearly every Friday night after class, we would go rock climbing at the Rec Center, walk to some nearby restaurant, and then go see the weekly Coffman movie sponsored by Gophers After Dark. It was always a great way to end the week. There are so many good memories, it is difficult to pick just a few. Several

more that come to mind (that I can certainly elaborate on) are: spending some weeks up at the Soudan Lab in northern MN, spending time with friends in Engineers without Borders, and performing with the Physics Force.

What are your favorite parts of your job? I will start with my least favorite things: broken nails, mandatory long pants and closed-toe shoes. The good news is that the least favorite parts of my job allow me to do my favorite parts. I love detectors. I love thinking of new ways to observe physical phenomena that allow us to better understand the world around us, or at least of ways to improve existing techniques. I work in a group that is doing active R&D to improve the design of a large detector that will be operational in 2020. So every day I get to go in and think about ways to make it better, one small piece at a time. This means I get to work on the design. Once I have drawn up a design, I get to build it! This is probably my favorite part. It is like really expensive Legos, that you have designed yourself. Once it is built, I get to run the system, take data, and analyze the data. It is a rare experience getting to be a part of all pieces of the experimental chain, and I feel very fortunate. The other best part of my job is the people I work with. Everyone is so welcoming and ready to teach if you have questions. I couldn't ask for a better work environment.

What got you interested in physics? I think it started back when I was a middle-schooler, and I loved looking at the stars. It must have started much sooner than that, actually, because I remember having a big book about the stars and planets when I was very young. I could not read all of it, but I loved looking at the pictures. If you'll allow me one off-color joke: One day, when I was probably three, my mom and I were riding in the car. From the back seat I asked, "Mom, is Uranus red?" She replied, "I don't know, is yours?" She still tells that story every chance she gets... Anyways, it was middle school when I discovered that there were people whose job is was to study the stars, and that those people were called astrophysicists. I then learned about the people who study the origins of the universe, and that they are called cosmologists, so I started telling people that I wanted to be a cosmologist when I grew up. Often, I was met with the response, "You want to do hair and make-up?", and I had to explain the difference between cosmology and cosmetology. Very different. My high school physics teacher was amazing, and he also encouraged my to pursue physics and astrophysics. So when I started my career at UMN, I took astrophysics classes. Unfortunately, I did not really like them. It was fun to study stars and galaxies, but the equations lacked the simplicity and beautiful symmetry of those in physics. For this reason, I chose to pursue physics instead. When I took MXPII, I knew I had made the right choice.

Tell us about your family. My family is wonderful. My mom and dad separated when I was young, but they always lived close to each other. Both of them made it abundantly clear that they believed my brother and I could do anything we set our minds to. They encouraged us to follow our dreams and believed in us 100%. I would not be where I am today without their love and support.

What are your hobbies? I have taken a serious interest in the issues of diversity and inclusion in STEM. So when I am not doing research, much of my time is taken up as the co-president of the Graduate Students of Applied Physics and Physics student group. I help plan social events to ensure the departments are welcoming environments for everyone, professional development events to help fellow grad students further their careers, and dedicated events aimed at promoting discussions about diversity issues. I also have a passion for science outreach. I get really excited about science, and I just want to share that with others. I do this though working as a tour guide at SLAC, helping organize events with Astronomy on Tap, and volunteering at various other outreach events in the area. Outside of the academic world, my main hobbies are camping, backpacking, travel, rock climbing, video games, and making food. I am also hoping to learn how to scuba dive soon. If I had any extra free time, I would like to learn another language.

Kelly with Professor Lucy Fortson.

PETER WAGNER

Recent University of Minnesota graduate Peter Wagner (B.S. 2015)did a six month internship after receiving his Bachelor of Science degree. He then took an unusual career path and hiked the Pacific Crest Trail (PCT) from Canada to Mexico. Having done so, he joins an elite group, only about 4,100 people total have done the complete 2,600 mile hike. Wagner made the unusual decision to hike Canada to Mexico (95% of all through hikers, go Mexico to Canada) and did it in four and half months--the average is about five months.

Wagner averaged 25 miles a day, with 12 hours of walking a day with minimal breaks for snacks. "When you get to your campsite at night you just unroll your sleeping bag and sleep under the stars. I was asleep in ten minutes usually. It was very little camping. Just all walking." One of the great challenges of the PCT is the elevation change. The trail covers everything from sea level to 14,000 feet. Wagner was determined to make it the entire way, despite setbacks such as forest fires limiting trail access in certain areas. "I walked everything from sea level to 14,000 feet. All the elevations were walked. All the views were seen. All the passive voices were used."

Wanger said that hitching rides and making support networks along the trail were critical to his success. "There were times when I slept on the shoulder on the interstate. I had a little tent that weighed about a pound, I rarely set it up. The weather was really quite nice. I had a little backpack, just the clothes on my back. Most of the weight was water. Water was a biggie. There were 25-30 mile sections with no water. I had to stay clear-headed and know what was available. I didn't get dehydrated or stranded without water."

Wagner said that his degree was helpful in teaching him to break down a challenging problem into manageable little chunks. As a physics student he learned to work through things methodically, planning thoroughly but not getting bogged down in the planning process. "The things I used in my undergraduate approach were very helpful: making

Wagner at the start (Manning Park, B.C.) and finish (Campo, CA) of the trail.

Wildflowers and smoke from forest fires make for a bea fortunate to avoid trail closings due to forest fires whi year.

approximations, and working through things in stages and iterations are applicable to any challenge."

Wagner said he excited to get back into applying his experience in physics at a real job. Since January 2016, Wagner has worked Ativa Medical in St. Paul. He is part of a team that is developing a commercial flow cytometer for point-of-care blood analysis. Wagner has been especially involved in designing and tuning the optical system for the cytometer.

Wagner relied on the hitching part of hitch hiking to get into town and buy supplies, do laundry and take a break from the trail.

Wagner at Glen Pass which is near the highest point on the trail. The pass is at nearly 12,000 feet of elevation. The highest part of the trail is Forester Pass which is 13,156 feet above sea level. The PCT is alligned with the highest portion of the Sierra Nevada mountain range making it one of the most challenging thru-hikes in the world. The PCT, the Appalacian Trail and the Continental Divide Trail are sometimes known as the Triple Crown of Hiking.

utiful view. Wagner said that he was ch had plagued hikers earlier in the

In Memoriam

Dietrich Dehnhard, 1934 -2016

Emeritus Professor Karl Dietrich "Dieter" Dehnhard died May 20, after suffering a heart attack the previous week. Dehnhard received his Ph.D. at the University of Marburg in Germany in 1964. He joined the University of Minnesota faculty in 1966 where he worked until his retirement in 2001.

Dehnhard's research specialty was experimental nuclear physics. He initially performed studies of nuclear structure using light ion probes at the Minnesota Tandem Laboratory. Dehnhard turned his attention to the use of heavier projectiles and extensively studied nuclear reactions and excitations using ions as a probe. This work brought him international recognition and started a series of collaborations with Max Planck Institute for Nuclear Physics in Heidelberg, Germany. Dehnhard then established a new research group funded by the Department of Energy to extensively study nuclear structures at the Los Alamos Meson Physics Facility. Later he researched hypernuclear physics, using kaon and electron probes at the Brookhaven alternating gradient synchrotron, the Brookhaven National Laboratory and the Thomas Jefferson National Accelerator Facility.

After retiring from a career in nuclear physics research and teaching at U of MN, Dieter focused on music - playing flute, practicing with friends and hosting and attending house concerts. Dehnhard was preceded in death by his wife of 42 years, Hilde. He is survived by his brother Hans; daughters Bettina Dehnhard (Dean), Susanne Carpenter (Bryan) and Karoline Dehnhard (Larry); and granddaughters Nicola Carpenter and Helen Trisko.

Stephen Gasiorowicz, 1928 - 2016

Stephen Gasiorowicz, who was most known for his contributions to quark model of hadrons, theory of glueballs and QCD confinement, and his role as one of the founding fathers of William I. Fine Theoretical Physics Institute (FTPI), died on June 3, 2016. Stephen was born on May 10, 1928 into a Jewish family in Danzig (currently Gdansk, Poland). Between 1920 and 1939 Danzig was a semi-autonomous city-state populated to a large extent by ethnic Germans. Stephen's father was a merchant. With the rise to power of the Nazis in Germany in 1933, persecution of non-Germans in Danzig increased, and Gasiorowicz's family had to move to Warsaw. When the Germans invaded Poland in 1939, the family fled East through the USSR, Romania, Turkey, Iraq, Pakistan and India. Only in India which at that time was controlled by Britain (the Polish Government in exile was its ally) did the family obtain residence permits. Stephen got his education there first in a Catholic school.

In 1946 the Gasiorowiczes were notified that their application for immigration to the US, which they filed before the World War, was finally approved. That same year Stephen sailed from Calcutta to San Francisco with his mother and sister (his father having died in India). He received his B.A. degree from UCLA in 1948 and Ph.D. in 1952.

Stephen was employed by Lawrence Berkeley Laboratory at the University of California, Berkeley, CA, as a research staff member. He received an offer of associate professorship from the Physics Department of the University of Minnesota, and in 1961 he moved to Minnesota where he stayed for the rest of his life. In 1963 he was promoted to full Professor. Stephen acquired a reputation of an excellent lecturer and was sought after as a visiting professor by major research centers such as DESY, NORDITA and the University of Tokyo. From 1979 till 1986 Stephen was Vice-President and a Member of the Aspen Center for Physics, Aspen, CO, and in 1987-89 the Acting Director of FTPI.

Stephen's legacy in physics education spread worldwide. Generations of physics students studied using the excellent textbooks written by Gasiorowicz, which include *Elementary Particle Physics, Quantum Physics*, and *Physics for Scientists and Engineers*. He was a Ph.D. adviser to such prominent physicists as Stanley Brodsky (SLAC) and William Bardeen (Fermilab).

Stephen retired in 1991. After retirement he continued work on textbooks and was an active member of the FTPI Oversight Committee. He also gave popular lectures at the Osher Lifelong Learning Institute.

Stephen was a real intellectual and humanist with a broad knowledge of literature and arts. Stephen's sense of humor was remarkable. He was a great story-teller and could snap a joke to any occasion. Stephen was absolutely great as a friend, always ready to help. He will be missed tremendously.

-Mikhail Shifman and Arkady Vainshtein

Mikhail Shifman, William Fine and Steve Gasiorowicz

Homer Mantis, 1918 - 2016

Emeritus Professor Homer Mantis died on January 16, 2016. Homer was born in Reading PA. Mantis earned his bachelor's degree (with honors) in chemistry from Lehigh University in Bethlehem, PA in 1938 and his Ph.D. in physics from the New York University in 1950. He worked as a research associate at the University of Minnesota throughout the 1950s, where he began collaborating with Ed Ney on high altitude balloon experiments. Mantis was also involved in a collaboration with Otto Schmidt of the Department of Zoology to create technology for tracking animals in the wild. Mantis' varied research pursuits included studying snow and permafrost and the prediction of tropical storms.

After a one year postdoc at the University of Washington, Mantis returned to the U as a Professor of Physics. His research throughout the 1960s was focused on the physics of weather. Mantis collaborated with Greek colleagues on a study of pollution in Athens in the last seventies. He continued publishing on this topic as late as 2001.

He is he is survived by his children John (Sarah), William (Chris Trost), Daphne, Katina Johnstone; five grandchildren, and two great grandchildren.

A fund has been established in Homer's memory to support graduate students in physics. Contributions may be directed to the University of Minnesota Foundation, P.O. Box 860266, Minneapolis, MN 55486-0266. In the memo line, write "Homer T. Mantis Conference Travel Award." You may also contribute online at: give.umn.edu/giveto/HomerMantis

Norton Hintz, 1923 - 2016

Emeritus Professor Norton Hintz died on February 11, 2016. Hintz joined the physics faculty in 1952, where he taught until his retirement in 1992. Over the decades he published some 90 papers on nuclear structure and the interaction of nucleons in the nucleus. He did research at the Los Alamos National Laboratory, NM, Brookhaven, NY, and at the Indiana University cyclotron.

Hintz was born in 1922 in Los Angeles, CA. He earned a two-year photography degree at Los Angeles City College in 1942 and a B.A. in physics at UCLA in 1944. He enlisted in the navy which posted him to an aircraft radar school in Cambridge, MA and then to the Naval Research Laboratory in Washington, D.C. After the war he returned to UCLA for a refresher year in physics before enrolling at Harvard University in 1948. After finishing his Ph.D. in 1951, Norton took a postdoctoral fellowship at the Cavendish Laboratory in Cambridge.

When Hintz arrived in Minnesota the following year, the Proton Linac was half built. He worked under Lawrence Johnston, who was in charge of constructing the Linac and John Williams one of the leaders in the experimental nuclear physics research program at Minnesota. Hintz was involved in making sure the beam stayed in its proper relative phase. After the Linac began operating, he designed a magnetic spectrometer to be used in inelastic scattering experiments on the Linac.

Hintz was recognized by his colleagues as a modern day renaissance man. In addition to physics he was a founding member of the Center Opera Company which later became the Minnesota Opera Company. On its 50th anniversary in 2012, the Minnesota Opera honored Norton as its founding board president. When once chided for his equal devotion to opera and experimental physics he shot back, "they both require large budgets."

Hintz had a life-long interest in photography (see photo below) and had a knack for capturing his subjects, often well-known physicists, in unreserved moments. In 2012 he worked with Professor Emeritus Roger Stuewer, of the History of Science and Technology to publish an autobiography in Physics in Perspective, My Life in Nuclear Physics, Photography and Opera. "Norton had a deep love of history, to which he himself contributed by writing a moving article," Stuewer said.

Al and Ardis Nier. Photo by Norton Hintz.

Tate Renovation
Progress Report

Left: Sheet rock in the subbasement. Right: Steel framing on third floor.

The Church Street addition.

Photo by Sharon Kressler.

Left: Completion ceremony for steel framing. Right: Steel support for the atrium stairs.

Photo by Sharon Kressler.

Steve Crouch, former Dean, College of Science and Engineering (CSE); Donna Whitney, Head of Newton Horace Winchell School of Earth Sciences; Ron Poling, Head of the School of Physics and Astronomy, Mostafa Kaveh, Interim Dean, CSE,

John T. Tate Hall

The renovation is 50% complete and on schedule to be finished by fall 2017, when the building will be officially named John T. Tate Hall. Exterior demolition and abatement were completed prior to the 2016 calendar year, with crews taking advantage of the relative quiet on Church Street during semester break to haul away about 800 tons of debris from the site. Roughly 80% of this material was recycled. The steel framework for the addition went up during the summer. Meanwhile the final layout of the building is starting to take shape: steel framing for interior walls are going up around the building and concrete floors of the new lecture halls are being poured. Restored windows and air handling units were installed in late summer/early fall. The complete enclosure of new addition is scheduled to begin in January 2017.

Weekly construction updates are provided to the School in the SPA News Digest. To sign up to receive the Digest, send a message to jenny@physics.umn.edu.