PHYSICS

AUTUMN 2017

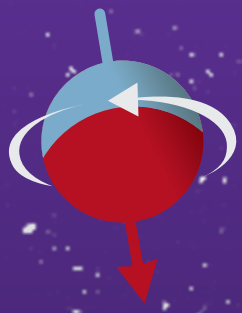
HUNTING THE **SMALLEST THINGS** IN THE **UNIVERSE** AT THE **COLDEST PLACE** ON **EARTH**

DEPARTMENT OF **PHYSICS**

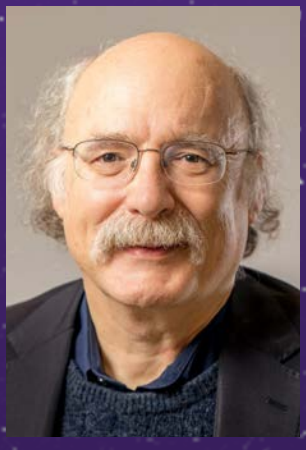
THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

THE 55TH ANNUAL ALPHEUS SMITH LECTURE • OCT. 10, 2017



F. Duncan M. Haldane, a British born physicist, is Sherman Fairchild University Professor of Physics at Princeton University, and a Distinguished Visiting Research Chair at Perimeter Institute for Theoretical Physics. He was awarded the 2016 Nobel Prize in Physics, along with David J. Thouless and J. Michael Kosterlitz *"for theoretical discoveries of topological phase transitions and topological phases of matter."*

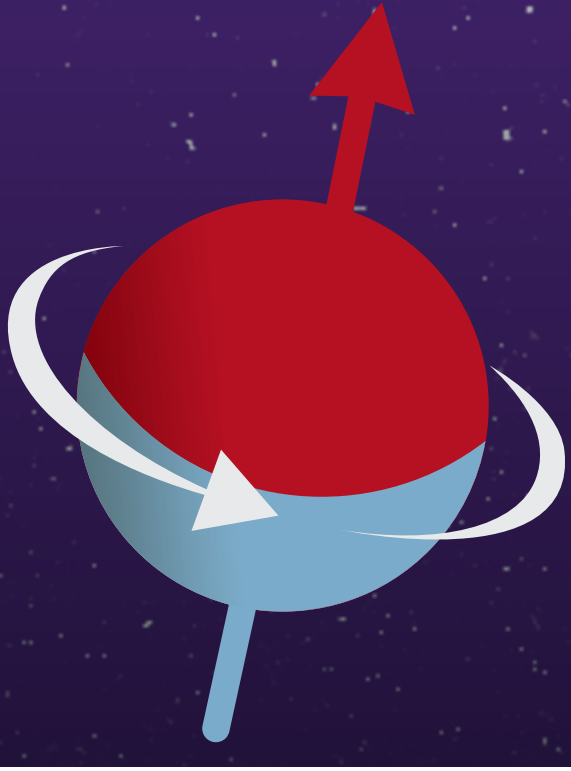


Haldane works on matter in different phases — gas, liquid or solid. At very low temperatures unusual phases may occur, such as superconductivity and atypical types of magnetism. To describe these phases and phase-transitions, Haldane used the mathematical tool of topology to develop his concepts. During the 1980s, Haldane was able to explain magnetic properties of chains of atoms in certain materials, knowledge that may contribute to developing novel materials and electronic components.

The Annual Alpheus Smith Lecture has brought leading-edge work of Nobel Laureates — 28 of them — and other prominent physicists to the community since 1960. The free, public lecture series is endowed by Robert Smith to honor his father, Physics Professor Alpheus W. Smith.

NOBEL LAUREATE F. DUNCAN M. HALDANE

ENTANGLEMENT: EINSTEIN'S GIFT TO QUANTUM MECHANICS



IN MEMORIAM

We regret to announce the passing of two extraordinary faculty members, widely honored for pioneering studies and commitment to physics education.

Professor Emeritus
Gordon Aubrecht
(2016)

Professor Emeritus
Gary Steigman
(2017)

Go to
u.osu.edu/memoriam
to read more about these remarkable individuals.

CONTENTS

ON THE COVER Preparing the balloon that will lift the Antarctic Impulsive Transient Antenna (ANITA) high over the antarctic ice.

THE VIEW FROM THE CHAIR'S OFFICE

Dear Friends of Physics,

It is a great pleasure to share a few of our recent success stories. For many of you, this is our first "meeting." While I just became chair in 2016, I've been part of our physics family since 1996. My research involves particle physics experiments at particle accelerators at Fermilab and CERN; and participation in an astrophysics satellite-based experiment using the Fermi Gamma-ray Space Telescope.

I am incredibly proud to chair one of the nation's premier physics departments. Our reputation attracts top faculty, postdocs, graduate and undergraduate students — some featured in these pages — along with our remarkable new faculty.

Our faculty, in the vanguard of collaborative, innovative research having global impact, wins honors and funding for ground-breaking research and exceptional teaching. On the cover you see the extremes our researchers will go to as they pursue critical, but elusive, discoveries.

Our powerful student programs — a magnet for the very best — prepare them to question, persevere and succeed in any field. Along the way, they build a track record of award-winning accomplishments.

We could not be more proud of our alumni. We believe the stories of Paul Weller and Jim Smith will inspire you as they have inspired us. Buckeye Love really is forever.

Exciting years are ahead. We are embarking on creating a vision of what it means to be a physicist in the 21st century, expanding our research directions and finding new ways to train our students to be successful and meet increasing global challenges.

We appreciate your generous support and hope you enjoy this issue. Please stop by any time and experience physics in action.

Brian L. Winer

Brian L. Winer
Chair

RECRUITING THE BEST

SENIOR SCIENTISTS AND A RISING STAR

Antonio Boveia, Assistant Professor

Research: Boveia studies debris of high-energy proton collisions at the Large Hadron Collider (LHC) for evidence of new particles and fundamental forces. Interested in dark matter and its possible interactions with ordinary matter, which could allow a "dark sector" of particles to be produced and studied, Boveia is developing new capabilities in triggering the LHC's ATLAS Experiment to extend searches for dark-matter production and other rare processes.

Why Ohio State? The physics department is large, diverse, and strong in several areas that can enhance my research program. Also, it is one of the few places involved in multiple LHC experiments, plus the ATLAS group has excellent facilities for detector electronics. CCAPP is a great resource for my dark matter research. And I like Columbus, which nicely balances elements of a larger city with a low cost of living.

Life beyond physics? I try to get as much exercise as I can manage; I like music, cooking, reading, travel, and spending time with my wife and our dog.

Marc W. Bockrath, Professor

Research: Bockrath studies properties of condensed matter systems with electrons confined in one or more dimension to yield low dimensional systems with novel properties. Such scales approach the atomic scale and the ultimate limit to miniaturization — yielding low dimensional systems with novel properties — carbon nanotubes, graphene, or any nanostructured material including single molecules. The goal: to understand new and interesting transport phenomena arising in nanostructured materials, and learning how to control and detect their mechanical motion. Potential applications include nano-scale switches, logic gates; and chemical, biological and mechanical sensors.

Why Ohio State? The Ohio State physics department's high profile and quality of the condensed matter physics program here were definitely a factor. Also, there is an abundance of colleagues here whose interests overlap with mine — both theoretically and experimentally, which offers the possibility of many productive and exciting collaborations.

Life beyond physics? While physics is definitely my #1 vocation and preoccupation, I DO very much enjoy such things as music, travel and hobbies.

Chun Ning (Jeanie) Lau, Professor

Research: Lau's research focuses on the fundamental electronic, mechanical and thermal properties of low-dimensional materials, such as graphene, carbon nanotubes and atomically thin black phosphorus to help guide the rational design of novel devices and functionalities based on these materials. Two-dimensional materials have many potentially promising applications like next-generation electronic materials, transparent electrodes, tunable broadband photodetectors, thermal management, strong and lightweight composites.

Why Ohio State? I was attracted by the vibrant materials research community and the strong physics department. I am excited to have the opportunities to collaborate with colleagues of similar interest but diverse background and expertise.

Life beyond physics? I enjoy travel and food — both preparation and consumption. When cooking, I usually go through cookbooks, ranging from French, Italian, Chinese, and Japanese to Greek and Moroccan. My favorite dishes are French: French onion soup, coq au vin, and chocolate soufflé.

HUNTING THE **SMALLEST THINGS** IN THE **UNIVERSE** AT THE **COLDEST PLACE** ON **EARTH**

What could be more daunting than searching for a virtually invisible particle that's so elusive that physicists had no physical evidence of its existence until 1956? Then decades passed before technology existed to allow the search for concrete evidence of what many had come to refer to as a "ghost particle."

This is just the kind of challenge that astrophysicists Jim Beatty and Amy Connolly find irresistible.

They are not alone; teams of international researchers are relentlessly hunting for high-energy neutrinos to extract clues to tell us more about the universe — and ourselves.

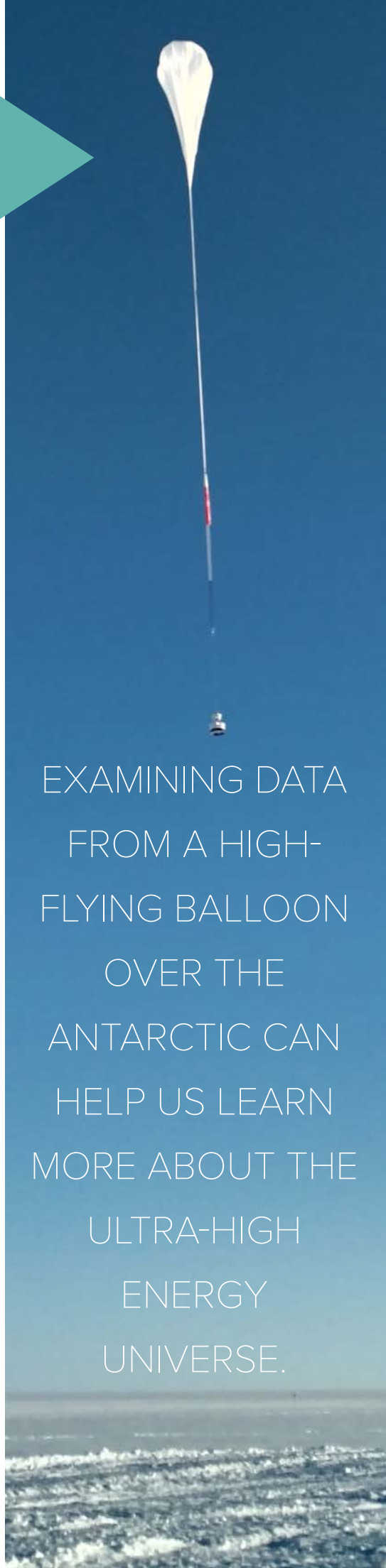
Beatty has tracked this nearly massless subatomic particle for three decades; Connolly since her days as a postdoctoral researcher at the University of California, Los Angeles, in the early 2000s.

Today, neutrino hunters rely on detectors located in Antarctica — the coldest, most remote place on Earth — and the optimal site for tracking neutrinos and a chance to finally unravel their mysteries.

Both Beatty and Connolly work on the NASA-funded **Antarctic Impulsive Transient Antenna** (**ANITA**) experiment, designed to study ultra-high-energy cosmic neutrinos by detecting radio pulses emitted from interactions with the Antarctic ice sheet — via an array of radio antennas suspended from a helium balloon flying above the continent.

The neutrinos, with energies on the order of 10^{18} eV, produce radio pulses in the ice due to the Askaryan effect. It is believed that high-energy cosmic neutrinos result from interactions of ultra-high-energy (10^{20} eV) cosmic rays with photons of cosmic-microwave background radiation — and are expected to be produced by the same energetic sources that produce cosmic rays.

Jim Beatty and Amy Connolly



EXAMINING DATA FROM A HIGH-FLYING BALLOON OVER THE ANTARCTIC CAN HELP US LEARN MORE ABOUT THE ULTRA-HIGH ENERGY UNIVERSE.

JIM BEATTY: Beatty works on two other experiments: the world's largest neutrino detector, the **IceCube Neutrino Observatory** (**IceCube**), an underground telescope with thousands of sensors distributed over a cubic-kilometer block under Antarctic ice. Spherical optical sensors, called Digital Optical Modules, are deployed on "strings" set deep within the ice. Each has a photomultiplier tube and single-board data acquisition computer that sends digital data to a counting house on the surface.

"IceCube's telescope is a powerful tool in the search for dark matter; it could reveal physical processes associated with the enigmatic origin of the highest-energy particles in nature," Beatty says.

"Neutrinos are notoriously tough to detect since they interact so weakly with other particles. But when neutrinos interact with atoms inside deep arctic ice, they can give off puffs of energy. As neutrinos pass through and interact, they produce charged particles, which give off light while traveling through ice at near light-speed."

Beatty led the team that developed electronics for the **Pierre Auger Observatory**, the largest cosmic-ray detector in the world.

"Picture an array of water tanks," Beatty says. "1664 of them about one mile apart — roughly the size of Rhode Island.

"When cosmic rays enter the atmosphere, they create a shower of subatomic particles that enter the tanks and produce flashes of light in the water. We also detect a faint flash of light in the atmosphere with sensitive cameras — it looks like a Christmas tree bulb flitting across the sky."

AMY CONNOLLY: Physicist Amy Connolly searches for these "ghost particles," using the Cerenkov radio technique, which she calls, "the most promising technique for a long-term program of ultra-high neutrino observatories that are capable of measuring data samples large enough to probe fundamental questions."

She examines data from the high-flying balloon experiment, ANITA; and the ARA (Askaryan Radio Array) deployed deep in the ice near the South Pole. Additionally, Connolly and her colleagues are working to develop a prototype of a proposed "super-ANITA," called EVA (Exa Volt Antenna) that would become the world's largest airborne telescope.

"Finding neutrinos is an important challenge," Connolly said. "They can help us learn more about the ultra-high energy universe; even about particle physics at higher energies than those probed by the LHC (Large Hadron Collider).

"The neutrinos we are looking for come from greater distances and of much higher energy than any extraterrestrial neutrinos seen before, which, to-date have originated from the sun or a single Super-nova.

"Antarctic ice is a great medium to search the universe for neutrinos. And, as ultra-high energy neutrino interactions probe higher center-of-mass energies than collisions produced at the Large Hadron Collider, they could point the way to new physics, perhaps through cross sections deviating from Standard Model expectations."

Connolly's group plays a central role in designing, building, testing and simulating the current ANITA (balloon-borne); ARA (in-situ) experiments and an ambitious future balloon-borne experiment, EVA.

She leads a team currently consisting of eight undergraduate students, five graduate students, a postdoc; and a research scientist, at the cutting edge of data analysis and performing the world's best neutrino searches at all energies above 10^{18} eV.

CART Facility: CCAPP Antarctic RF Test Facility CART, housed in the PRB, a collaboration between the Connolly-Beatty Laboratory and the Center for Cosmology and AstroParticle Physics, provides Ohio State and academic partners access to advanced facilities to develop, fabricate and test ultra-fast (>3 GHz), ultra-sensitive, research-quality RF-electronics. It is a lead hardware developer for the Askaryan Radio Array (ARA), the Antarctic Impulsive Transient Antenna (ANITA) and the ExaVolt Antenna (EVA).

JAMES J. BEATTY is professor of physics, professor of astronomy and former physics department chair. In 2016, he was appointed to serve a three-year term on NASA's Physics of the Cosmos Program Analysis Group (PhysPAG) Executive Committee, which plays an important role in the future of NASA's investment in Physics of the Cosmos science.

AMY CONNOLLY is associate professor of physics and received an NSF CAREER Award in 2013 to support her Antarctic neutrino research. It also provides funds for ASPIRE, two, annual, week-long summer workshops that give high-school women hands-on opportunities to explore physics. u.osu.edu/aspire. Connolly was elected to serve on the APS Division of Astrophysics' Executive Board, 6/17-5/20.

MAKING NEWS THAT MATTERS

Collaborations: High Impact. High Energy. Interdisciplinary.

Securing funding for both theory and experiment is important because it facilitates, enhances and encourages collaboration among the respective groups. Another critical part of this grant enables training graduate students and postdocs in an environment that utilizes the latest developments in computers, electronics and data mining.

— Brian Winer

A three-year, $5.65 million grant from the Department of Energy to Ohio State's High Energy Physics Group in 2017 funds 13 faculty members, their postdocs and graduate students on wide-ranging research in fundamental physics. Long-time major players in worldwide efforts to untangle the universe's fundamental mysteries, they've searched for physics beyond the standard model; the source of dark matter; and precision studies of standard-model processes.

EXPERIMENTAL PHYSICISTS: Assistant Professor Antonio Boveia, Professors Stan Durkin, K.K. Gan, Christopher Hill, Harris Kagan, Richard Kass, and **Professor and Chair Brian Winer** play vital roles at the Large Hadron Collider's two general-purpose detectors — ATLAS and CMS. They make major contributions to both hardware and data analysis and were an important part of the team finding the elusive Higgs Boson in 2012 — perhaps the most momentous discovery in the field of particle physics.

THEORETICAL PHYSICISTS: Professors Eric Braaten, Samir Mathur, Stuart Raby and **Assistant Professor Linda Carpenter** ponder the field's most puzzling, wide-ranging questions, from physics beyond the current standard model, to what's inside a black hole, the nature of dark matter and precision calculations of standard-model processes.

ASTROPHYSICISTS: Physics **Professor Klaus Honscheid** and Astronomy **Professor Paul Martini** study dark energy via non-accelerator based methods, leading efforts in design, construction and analysis of data from a series of ongoing experiments: the astronomical sky surveys, including the Dark Energy Survey, the Dark Energy Spectroscopic Instrument and the Extended Baryon Oscillation Spectroscopic Survey.

Although we have a strong group of researchers, attracting a strong student pool, graduate training and research is spread over three graduate programs and several departments and colleges. Bringing them together creates a seamless training experience for these students who have many different undergraduate backgrounds. Learning from each other and a wide spectrum of mentors, they receive broad, core-training in macromolecular and physical biochemistry; biophysics fundamentals; responsible conduct of research; and public communication skills. We supplement this with monthly workshops, an annual symposium, alumni presentations, continuous ethics training, and discussions of best practices.

— **Ralf Bundschuh**

NIH's National Institute of General Medical Sciences (NIGMS) funds **Physics Professor Ralf Bundschuh**; **Biological Medicine and Pharmacology Professor Jeff Kuret**, and **Chemistry Professor Tom Magliery** to establish an interdisciplinary Molecular Biophysics Training Program (MBTP) at Ohio State. The new program, launched summer 2017, creates an integrated training experience for students from three different graduate programs (Biophysics, Ohio State Biochemistry Program, and the Biological Division of Chemistry). All students receive core training in macromolecular and physical biochemistry, biophysics fundamentals, and effective communication to the public. NIH resources, matched by Ohio State, will fund six students, two from underrepresented minorities.

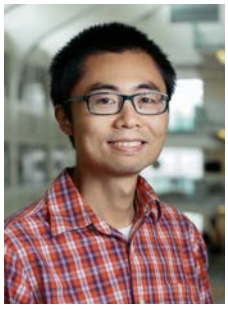
Given the critical role these devices play in wireless communication and information technology, the breadth and depth of the work's impact will be significant. Additionally, this partnership will form the foundation for broader efforts to increase public engagement in science via local outreach activities designed to enhance diversity programs in STEM across all four participating university campuses.

— **Ezekiel Johnston-Halperin**

NSF Supports Physics Professor Ezekiel Johnston-Halperin, PI, and Ohio State, lead institution, in developing a novel way to construct microwave circuits. The four-person Ohio State, Yale, U. Iowa, and Colorado State team received a $2 million NSF Engineering Frontiers Research Initiative (EFRI) grant, to work on next-generation microwave electronic devices based on novel magnetic and topological properties of materials, being produced by Johnston-Halperin's group.

AWARD-WINNING FACULTY

Key Career Recognition



Assistant Professor Yuan-Ming Lu's five-year, $477,294 National Science Foundation (NSF) CAREER Award supports his advanced studies of the properties of solid-state materials. Using quantum mechanics and statistical physics to give him a deeper look at how electrons organize themselves in complicated materials, Lu hopes to develop novel ways to detect and design topological orders — highly desirable for their potential applications — such as quantum computing. While quantum computers won't be available any time soon, the wait will be worth it, taking users to a whole new level of computational power and accuracy.

Dongping Zhong, the Robert Smith Professor of Physics; and professor of chemistry and biochemistry's five-year, $2,143,295 National Institutes of Health (NIH) Maximizing Investigators' Research Award (MIRA), is driving his group's focus on new research frontiers. Their research, relating dynamics and structures to functions at the most fundamental level is critical to understand elementary processes in biological systems, having important implications for drug transport and design. Using state-of-the-art femtosecond lasers and tools of molecular biology facilitates both molecular recognition and ultrafast protein dynamics in several important biological systems, including DNA-repair enzymes and photo-sensory proteins key to the synchronization of biological timing (circadian rhythm).

Physics Assistant Professor Christopher Orban, Ohio State Marion, funded by a 2016 Battelle Engineering, Technology and Human Affairs (BETHA) Endowment grant, leads an interdisciplinary team developing coursework, public lectures and outreach examining the work of astrophysicist-priest Fr. Georges Lemaître. This remarkable figure of early 20th century cosmology helped lay groundwork for the Big Bang theory. This past summer, Orban, ran a "Physics of Video Games" camp, grades 9-12 at Columbus Academy, part of a STEMcoding effort Orban leads to integrate computer science into high school STEM courses, **funded by Ohio State's Office of Academic Affairs' Connect & Collaborate Grant Program.**

Physics Professor Louis DiMauro, received the 2017 Arthur L. Schawlow Prize in Laser Science from the American Physical Society at their annual meeting. DiMauro is recognized for "groundbreaking work in several areas of high-field and ultrafast optical science, from high harmonic generation and free electron lasers to attosecond science." This prize was established in 1991 and endowed by the NEC Corporation. This annual award is given to laser scientists whose outstanding contributions to basic research using lasers advances knowledge of the fundamental physical properties of materials and their interactions with light.

APS FELLOWS

Three Physics Professors: Ilya Gruzberg, Christopher Hill and Ezekiel Johnston-Halperin elected to the 2016 class of American Physical Society Fellows, for exceptional contributions to physics. This distinct honor is the highest badge of peer-recognition. They join the ranks of 27 other Ohio State physics APS Fellows.

(FROM L TO R)

- **Ilya Gruzberg** (Condensed Matter Physics) Contributions to the theory of critical phenomena near Anderson localization-delocalization transitions in disordered electronic systems, including the integer quantum Hall transition and its variants in different symmetry classes
- **Christopher Hill** (Particles and Fields) Contributions to silicon tracking detectors at hadron colliders and developing novel analysis techniques, particularly those used in the searches for beyond the standard model particles with long lifetimes
- **Ezekiel Johnston-Halperin** (Materials Physics) Pioneering studies of magnetic, spintronic, and electronic properties of organic and inorganic materials, including groundbreaking work with organic-based ferromagnets

SPECTACULAR STUDENTS

Khalida Hendricks:

From Jumping with the Golden Knights to Hunting Subatomic Particles

Khalida Hendricks, advised by Associate Professor **Amy Connolly**, is now entering her fifth year in the particle physics graduate program. How she got here is a story worthy of a movie.

NOT your typical physics graduate student, the easy route is just not in her DNA.

Not really sure what she wanted to do, Hendricks joined the Army after high-school graduation. “I had always thought citizens should do some sort of service for their country; plus, it would give me time to figure out what I wanted to do; and secure money for college when I did.”

In the meantime, Hendricks, who really enjoys learning, surfed the internet, looking for new and interesting things. Soon after joining the Army, she found a website called, The Particle Adventure. “It’s this cheesy, animated introduction to fundamental particles and interactions, with lots of bad puns; but it was fun, easy to get through and made me want to know more.”

As years passed, her desire to study physics became more pressing. While Hendricks kept planning to leave the Army and become a physicist, the Army kept offering her interesting opportunities, such as a chance to try out for the U.S. Army Parachute Team. Always adventurous, she confessed, “That seemed too cool to pass up, so I jumped on it — literally! I tried out and spent the next three years as a member of the U.S. Army Parachute Team, better known as the ‘Golden Knights.’”

From there, Khalida kept jumping, but along the way knocked-off physics and applied-math degree pre-requisites. Finally, she left active duty and finished her degree, in person, at North Carolina State.

“It was a long journey, but so happy it ended here. I really love the people and the atmosphere of the department.”

Future plans? “I would like to work at an institution large enough to do good research, but small enough to make a real difference for students who might not have as many opportunities as at a large school.”

No surprise: In 2016, Hendricks was named a Tillman Scholar. pattillmanfoundation.org/scholar/khalida-hendricks

Kaeli Hughes:

Neutrino Hunter

Physics major Kaeli Hughes, who graduated May 2017, is a winner — winning 2nd place at Ohio State’s annual Denman Undergraduate Research Forum for work on neutrinos; receiving an NSF Graduate Research Fellowship Program Honorable Mention for, “Mapping the Universe in Ultra High Energy Neutrinos with the Askaryan Radio Array;” and 2016 Goldwater Scholarship Program Honorable Mention.

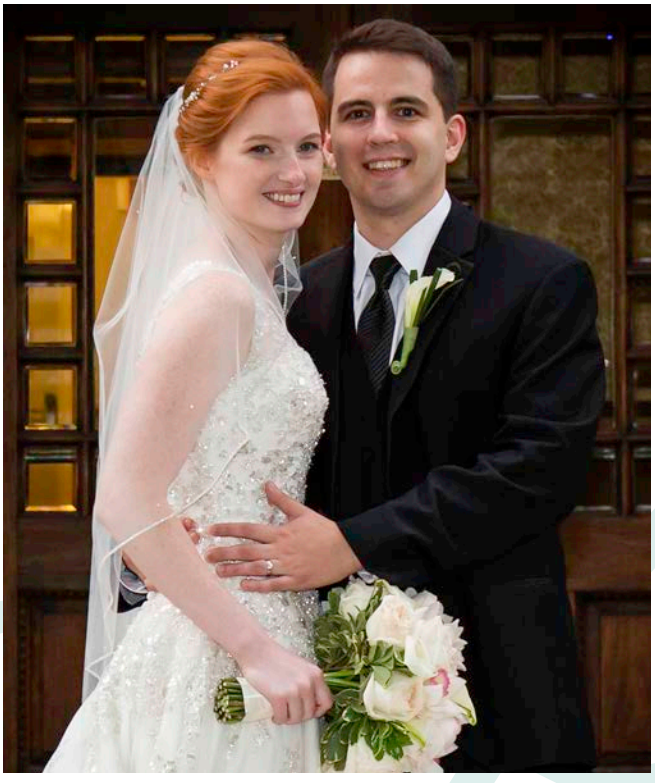
Research advisor Amy Connolly’s group searches for neutrinos. “My project worked on implementing machine learning (a way to teach a computer to solve complex problems) into techniques used to analyze data.” Hughes said. “While it needs tweaking before its full potential can be utilized, we’re optimistic about future results!”

Hughes loved high-school chemistry classes and planned to major in chemistry. Then, she took introductory physics classes, and, “realized physics allows you to solve all sorts of interesting problems at a fundamental level. I loved that all of my homework problems were like puzzles!

“Growing up in a Columbus suburb meant Ohio State was always on my radar. But visiting sealed the deal. Ohio State felt like a community; choosing to become a Buckeye was one of the best decisions I’ve made!”

Now Hughes, selected an Eckhardt Scholar at the University of Chicago, is off to pursue a PhD in Physics.

PRESIDENTIAL FELLOWS
A True Buckeye Love Story



Beth Bushong and **Tim McCormick** first met at Ohio State in a graduate-level condensed matter physics class, taught by Tim's advisor, Nandini Trivedi. Beth was injured during the first semester, so borrowed notes from Tim to catch up on work she had missed, figuring going to the professor's student was a good place to get notes.

Tim began his first year of graduate school at Ohio State in 2012. Beth transferred from the University of Georgia as a second-year graduate student in 2013. The rest is history, and a true Buckeye Love Story culminating in a wedding ceremony on Oct. 22, 2016.

Beth and Tim talk about:

Why Ohio State?
Ohio State has a great physics program, specifically in condensed matter physics, which is what we are both interested in. (Beth is an experimentalist and Tim a theorist.)

After-graduation Plans:
We want to pursue post-doctoral positions in condensed matter physics and are applying for positions this autumn. Currently, there are a lot of unknowns, but we are confident we will find positions together somewhere doing what we each enjoy.

The Dynamics of Two Married Physicists:
We don't really think that we are much different from most other married couples. It started with an attraction, like an electron and a proton, but we found that we enjoy being with each other and have so much in common that goes way beyond just attraction. A unifying theme in condensed matter physics is that of emergence, or systems, whose whole is greater than the sum of its parts. Good relationships have many emergent properties; two individuals combined create something unique that would not exist if they were apart.

Working at the Center for Emergent Materials (CEM):
The Center for Emergent materials is a great place to work for both of us. With so many people studying similar, but not identical — topics, there are always people to bounce ideas off of or start collaborations with. Because there is so much exciting research going on, CEM brings in great people for talks and conferences. Both of us have benefited from the interdisciplinary interactions we have taken part in at CEM.

Favorite Things Besides Physics:
Tim enjoys playing guitar and Beth practices yoga. We both like to read, play board games, and spend time with our two dogs, Tess — a black lab mix; and Brady — a Bernese mountain dog.

Photos: Black Raven Imagery

BUCKEYE LOVE LASTS A LIFETIME:

82 YEARS LATER **PAUL WELLER** STILL LOVES PHYSICS

Last summer, ASC Development Director **Rick Harrison** met with physics alumnus **Paul Weller** at his home on Dutch Island, Isle of Hope, a gated community just outside Savannah, Georgia. This turned out to be a most memorable visit.

"His son Ronald P. Weller (in his 70s) answered the door and Paul came zooming down the hallway in his mechanized chair with a huge smile on his face," said Harrison. "We sat down for appetizers on his enclosed back porch overlooking the Herb River and Paul's boat dock where he told me his story."

It's very possible that 104 year-old Weller (born July 1, 1913) may be one of Ohio State's oldest living alumni.

He grew up in Cuyahoga Falls, Ohio, where his father started a funeral business; he attended Western Reserve Academy (WRA) founded in 1826 in Hudson, Ohio, a private, mid-sized college preparatory school; its college section, now Case Western Reserve University.

Although his parents were not college graduates, they insisted he go, sending him to Vermont's Middlebury College. Then, the Great Depression took its toll; private school was not an option, so Paul began his sophomore year at Ohio State.

He'd always done well in chemistry and physics, so decided to study physics and take mechanical engineering classes.

"When I showed him today's physics-degree programs, he was excited to see a BS in Engineering Physics, wishing it were available in his day."

Tuition of $24.75/quarter was a burden for many in those years. Paul, a member of Kappa Delta Rho (no longer on campus) became house manager, because he needed the money.

The stadium was just 10 years old — but Paul could not often afford the games.

He met his late wife Mary Mosteller (social work '35) walking home one day. She just happened to be the sorority girl two doors away.

There was no career planning office, even his professors weren't sure what to recommend he do with physics other than teach.

Not surprisingly, he floundered a little after graduation, and took a job with a trade association for morticians, traveling across the country visiting funeral homes.

He went back to Ohio State, got an MBA in 1938 and worked at Goodyear Tire & Rubber on aircraft engine mounts, necessary work that kept him out of WWII, followed by various sales and market-research jobs across the country.

Paul moved to Savannah, Georgia, in 1962, became sales manager for Southern Nitrogen Company (later Kaiser Agricultural Chemical). He retired in 1978 and started his own company, designing metal flanges used in the connection of steel culvert pipe.

"Over the course of a two-hour visit, Paul served me a home-cooked meal — crab cakes, salad, veggies, southern biscuits and cherry pie; and regaled me with stories of Savannah's history.

"He loved the pictures of Ohio State I brought him, especially his early '30s fraternity photos I found in the *Makio*," said Harrison.

Weller keeps busy: church activities, tinkering in his workshop, boating, fishing, and a cat named Socks. After Harrison's visit, Weller had his knee replaced and graduated to a walker. This is a man you cannot keep down.

Paul Weller's World in 1935

- Franklin D. Roosevelt was President
- Lindbergh kidnapping and murder trial underway
- The Dust Bowl hit the Great Plains
- Social Security Act signed into law
- Elvis Presley was born
- Avg. cost of a new house: $3,450; avg. wages/yr, $1,600
- Cost of gasoline: 10 cents; avg. new car: $625
- Hoover Dam completed
- Babe Ruth hit the 714th and final home run of his career
- Ohio State 6th President: George Washington Rightmire
- Ohio State enrollment surpasses 15k

ALUMNUS JIM SMITH:
The Gift of Time

Physics alumnus Jim Smith, PhD, knows that time is money and that working to put yourself through school chews up a lot of it. Smith is now retired after a career in industry and at Argonne National Laboratory. His work in multidisciplinary environments convinced him of the value of the physics curriculum.

"Now, I have time to think about a lot of things and I realize I was lucky," Smith says. "Although I did have to work, a then-and-now comparison gives a dramatic insight into how financially good it was for my generation. Annual tuition of $300 would be rewarded with a salary around $6,000 or more — an inconceivable ratio today. At that time, school debts could be paid off after graduation."

"Putting things in context made me realize that I didn't have it so bad — it IS worse today — and it made me think about what's important and what is not."

Two years ago, Smith decided that what was important to him was to try to make getting a degree in physics a little easier for students in need and established a scholarship fund.

Most of all he considers it a gift to be able to share his good fortune with today's physics students.

Smith who has used that education to solve many problems with inventive solutions, hopes others will think about how they too might smooth the way for students. Smith now lives in Illinois, but visits and talks to physics students as often as he can.

"It's a way of staying connected and sharing one of the most important experiences of my life. Today's students are amazing, energetic, motivated and super-smart."

> "We didn't have good career counseling back then, but it all worked out well. Even at that age, it was clear to me that physics is not only the best science education you can have; it's the best education for teaching you how to think, reason and question. Once you master that, you can solve problems and find solutions to virtually anything — you have all the tools you will ever need firmly embedded in your brain."
>
> — Physics alumnus **Jim Smith**, PhD

TWO OF THOSE STUDENTS SAY:

Your generous support has been a great relief to me. I had been anxious about whether I could smoothly finish my four years; the scholarship allows me to work fewer hours, finish my studies and seek a successful career, hard for women in physics.

— Victoria Niu

I am extremely grateful for this scholarship and the doors it has opened for me. It has helped me focus more on my studies and look for opportunities, including unpaid internships and research opportunities, instead of only jobs that pay.

— Michael Reinhard

PHYSICS BRIDGE PROGRAM:
Expanding STEM's Pipeline Since 2013

The MS-to-PhD Physics Bridge Program started in 2012, with a goal to increase the number of underrepresented minority (URM) students qualified to enter and complete physics doctoral programs. Unanimous support from the Physics faculty reflected a consensus that there were URM students who could be successful in PhD research, but had gaps in their academic preparation that would preclude direct admission into PhD programs. Shortly thereafter, the American Physical Society (APS) selected OSU to be one of the first two APS-funded Physics Bridge Program Sites, and partnered with OSU to expand this model nationwide. The Physics PhD program has since experienced a dramatic increase in diversity and improved support for all graduate students. The impact and example of the OSU program has been so significant that the APS is "*... specifically calling out OSU in our national conversations, as an example of how a top-tiered physics graduate program at a research intensive public institution has combined its passion for pursuing cutting edge research and a commitment to serving all students from all backgrounds.*"

PROGRAM METRICS

- First 9 Bridge students transitioned into PhD programs at OSU or elsewhere; others still progressing in Bridge Program
- First OSU Physics PhD from program expected 2018-19
- Bridge Program and other related efforts have made significant impact on diversity and student success in entire OSU Physics PhD program

CRITICAL INSIGHTS AND DEVELOPMENTS FOR STUDENT SUCCESS

- Partnership with APS for nationwide recruiting helps find students well-matched to OSU Physics
- Holistic mentoring needed by research, academic and peer mentors
- Day 1 assessments developed to identify individual curriculum goals
- Additional academic support via conceptual group work tutorials highly beneficial
- Close progress monitoring necessary for real-time course corrections
- Practices developed for Bridge students also highly beneficial for all PhD students

GOALS:

- Continue to support current and former Bridge Fellows to obtain PhDs
- Assemble portfolio of funding sources to maintain cohort of three new Bridge Fellows per year
- Serve as a model for other STEM graduate programs at OSU and nationwide

CONTACTS:

Co-Directors: Profs. Jon Pelz and Jay Gupta (physics.osu.edu/masters-phd-bridge-program)

Christopher Orban

YOUNG SCHOLAR'S PROGRAM:
Incoming Freshmen Get Crash Course in Physics Prep

Two years in a row, Assistant Professor **Christopher Orban** has run a three-week physics prep workshop for Young Scholars Program (YSP) for incoming freshman. The Office of Diversity and Inclusion works with urban school districts statewide to help prepare students for college. Studies show approximately 25 percent of students have trouble with freshman physics courses. This inspired Orban and graduate student **Humberto Gilmer** to run a daily, three-week physics prep session for 24 YSP incoming freshman, using worksheets spanning the typical range of classical physics topics.

WE WOULD LIKE TO HEAR FROM YOU!

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Physics Research Building
191 W. Woodruff Ave.
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Physics Chair's Discretionary Fund

Provides the chair with the flexibility to fund small but urgent academic and research priorities as well as the ability to host important community building events within the department

Fund # 302325

James L. Smith Student Support Fund

Provides scholarships for undergraduate physics majors

Fund # 315358

Bridge Program

support for Physics Graduate Bridge Program for under-represented minority students

Fund # 315288

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