Fall 2020

PHYSICS & ASTRONOMY

CrossSections

The Newsletter for UT Physics Alumni & Friends

A Successful Year, Against All Odds

It's been a long and gloomy year. The first major event, our midcycle program review, was held in late February, which now seems eons ago. The site visit was completed in the nick of time, a few weeks before the Knox County Health department issued the "safer at home" order due to the worrisome rise in COVID-19 cases. Students and instructors had to move abruptly and en masse to a virtual learning environment with thousands of parallel Zoom meetings and tens of thousands of participants system-wide each day. This has been a most challenging experience for students, faculty, and staff, and of course we all miss the personal interactions with students and colleagues. While some in our physics family were infected by COVID, we are immensely grateful that none of them suffered life-threatening health conditions. The department reviewed well and 2020 became a very busy and remarkably successful year. These are some of the people who made it happen:

Kudos to **Drs. Marianne Breinig, Christine Cheney, Kate Jones**, and the **physics staff** for creating a safe work environment in Nielsen. This entailed, among other things, implementing new seating plans for offices and labs and stocking PPE supplies, disinfectants, wipes, hand sanitizer, etc. Thanks to their efforts, we were able to offer hands-on face-to-face laboratories every week. Marianne and Christine and **Dr. Sean Lindsay** did a formidable job in creating online content for many of our laboratory sessions. Students were able to split their lab assignments between a face-to-face and an online setting every week. Many students expressed their appreciation for having the opportunity to interact face-to-face with their lab instructor, as nearly all other course instruction was done online. **Paul Lewis and Ricky Huffstetler** even designed disposable eyepiece covers for our telescopes so that our rooftop astronomy sessions could continue, albeit with reduced capacity. Finally, **Christine Cheney and Showni Medlin** did a marvelous job putting COVID-adapted teaching schedules together for fall 2020 and spring 2021. This was an enormously challenging task, but the rollout of the fall schedule was mostly flawless.

Kudos to our **Graduate Teaching Assistants** for rising to the challenge. You went the extra mile, serving the needs of different groups of students, including those who were sick or quarantined. Thank you for your presence in the labs, and for organizing and coordinating all the extra review sessions on Zoom and daily discussions on Discord. Thanks to all faculty for being so flexible and adaptable in presenting your online course materials and accommodating the diverse needs of our students. Finally, thank you to our students, for doing your part in wearing your masks, cleaning your stations, and physically distancing from each other. It is remarkable to see how everyone rose to the challenge. I do not recall any major complaint, which is a testament to the collegial "can do" attitude in our department. Traditionally, we have about 15 graduating seniors each year. The number of majors has been steadily growing and for the first time ever, we shattered the magic "20 barrier." This year we graduated 31 bachelors! In addition, we graduated 18 PhDs and 9 master's students.

In other news, this year we welcomed three new faculty members. You can read their profiles in this newsletter. Briefly, **Assistant Professor Joon Sue Lee** joined our

What's Inside

department in January. Joon Sue is an experimental condensed matter physicist, received his PhD degree from Penn State University in 2014, and completed his postdoctoral work at the University of California in Santa Barbara. He is interested in the electronic, magnetic, and superconducting properties of semiconductors and novel quantum materials with potential applications for quantum computing and spintronics. **Professor Adrian Del Maestro** is a theoretical and computational physicist with interests in the study of phase transitions, quantum fluids, ultra-cold bosonic gases, superconductors, and topological states of matter. He obtained his PhD from Harvard University in 2008, and held postdoctoral positions at the University of British Columbia and Johns Hopkins University before joining the faculty at the University of Vermont in 2011. He won numerous research grants including the prestigious NSF Career Award, and served as lead PI and Director of the Vermont Advanced Computing Core. Adrian will lead the theory effort of the recently established interdisciplinary research cluster on Quantum Materials for Future Technologies. In this role, he will develop new interdisciplinary courses in machine learning and quantum technologies. Last but not least, **Assistant Professor Tova Holmes** is an experimental high-energy particle physicist who received her PhD from the University of California at Berkeley in 2016. Tova held a postdoctoral appointment at the Enrico Fermi Institute at the University of Chicago, and was stationed at the European Organization for Nuclear Research (CERN) in Geneva, Switzerland. Her primary research interest is the search for physics beyond the venerable Standard Model of particle physics. Tova's expertise includes the identification of long-lived subatomic particles, hardware-based pattern recognition, and electronic trigger systems. Three additional faculty searches are underway, which bodes well for the future of the department.

"It is remarkable to see how everyone rose to the challenge. I do not recall any major complaint, which is a testament to the collegial 'can do' attitude in our department."

We were thrilled to hear that **Professor Geoff Greene** won the prestigious Tom W. Bonner Prize of the American Physical Society. The APS Bonner Prize is the nation's most prestigious award in all of nuclear physics, and this is the second time that one of our faculty members has won the honor. (Witek Nazarewicz, now at MSU/FRIB, won the prize in 2012.) This clearly attests to the high stature of our nuclear physics program. Geoff will accept the award at a ceremony in April.

Congratulations to **Lucas Platter and Andrew Steiner** for their promotion to associate professor with tenure. They run prolific research programs in nuclear and nuclear astrophysics, respectively, and you should expect to hear more about their accomplishments in years to come. Thank you, **Professor Soren Sorensen**, for leading the diversity taskforce in creating an ambitious plan to improve the departmental climate and enhance the diversity of our faculty and student body. It was adopted with unanimous faculty approval, which is quite a feat. The implementation of the plan is now moving at warp speed thanks to the new departmental community committee led by **Professor Adriana Moreo**.

Associate Professors Christine Nattrass and Steve Johnston were appointed as undergraduate and graduate program director, respectively. Their enthusiasm and drive are making a significant impact on the department's teaching mission, particularly as it relates to the advising experience of our undergrads. Christine is transforming our traditional advising to more of a mentoring experience, while the technical aspects of advising are now handled by our professional advisor **Max Steele**. Max is a member of the College advising staff and came to us with an MA in Educational Studies, Higher Education and Student Affairs from the Ohio State University. Steve also leads the graduate recruitment committee and our cohorts are getting better and more diverse. Unfortunately, due to COVID-19, many of the international students could not come this year.

I am closing on a sadder note. This summer, our former colleague **Professor Ward Plummer** passed away unexpectedly but peacefully at his home in Baton Rouge, Louisiana. He was 79. Ward was a UT/ORNL Distinguished Scientist and Professor in our department from 1992 until 2009. He was the founding Director of the Joint Institute for Advanced Materials and a member of the National Academy of Sciences. Ward was instrumental in recruiting several of our condensed matter faculty and made a big impact on the lives and careers of his former mentees. I will always remember him as a kind-hearted person whose teachings still guide me in my professional career. His passion and drive for science laid the groundwork for our current successes, and we thus owe him much gratitude.

I wish you a joyous holiday season and please stay safe.

—Hanno Weitering, Professor and Department Head

Building Materials, Atom by Atom

Joon Sue Lee knows what he's looking for before he lays down the first atom. A builder in reduced dimensions, he considers the physics before he chooses the elements. He crafts nanostructures, develops devices, and makes careful measurements to show the sophisticated quantum phenomena he envisioned when he started. This is the welcome expertise he brought to the physics department when he joined the faculty as an assistant professor at the outset of 2020.

A Boy with Curiosity

A native of South Korea, Lee was born in Gwangju, meaning city of light, and grew up in the capital city, Seoul. Physics, it turns out, came quite naturally to him from the early days of childhood.

"I was a boy with curiosity," Lee said, who liked to disassemble small electronics like clocks and radios, some of which were never reassembled, unfortunately.

"It was fun to learn how things are connected and working," he continued. "I naturally liked physics, which is the study that tries to explain nature from small things like subatomic particles to the big things like the universe."

He attended Seoul National University for his undergraduate studies, with a dual major in physics education and electrical engineering. He explained that he chose the former because he valued his own education, which encouraged and cultivated his interest in physics. The latter was rooted in a desire to explore what applications would build on the physics fundamentals he had learned. That's where he discovered the area that would become the basis for his research program.

"Applications based on quantum phenomena caught my attention," he said. "(That) brought me to experimental condensed matter physics. I learned that applications in quantum matter are largely determined by the properties of materials. I finally became interested in quantum materials and their applications in quantum information science and spintronics."

Lee went on to earn a master's degree in physics at Seoul National University and then moved to the United States for doctoral work, earning a PhD at Penn State in 2014. He stayed in State College for a postdoctoral appointment, then moved to the University of California, Santa Barbara, for a second postdoctoral position. On January 1 he joined the UT faculty, where he's part of a growing program in quantum science, both in the physics department and across the university. His specialty is in creating and characterizing materials on the quantum scale with an eye toward potential devices.

Quantum materials are a new frontier, as novel and interesting (called *emergent*) phenomena can show up when electrons are confined in reduced dimensions. Spintronics, for example, uses an electron's spin to generate and maintain current much more efficiently than conventional electronics. Topological superconductors could be used for stable qubits needed to make scalable quantum computing a reality. With that promise, however, come a fair number of challenges.

"Quantum phenomena are delicate and require clean materials systems and careful measurement schemes," Lee explained. "For my research, synthesis of high-quality materials is the first challenge, device fabrication with minimal disorder is the second, and low-temperature transport measurements with minimal noise is the third."

Lee carefully builds quantum structures using molecular beam epitaxy (MBE), depositing atomic layers one on top of the other, like LEGOs. Often, however, the elements that comprise a material can impose limits on the system he wants to create.

"Some are toxic like arsenic, some are corrosive, and some are pyrophoric," he said.

He added that scientists may avoid hazardous elements, but if they choose to use them, they need a careful plan to mitigate exposure. Aside from potential hazards, there's a host of other considerations in choosing elements: how well they can be controlled as they're deposited on a base layer (substrate), how they respond to temperature and pressure, and whether there's a substrate commercially available that will be a good match for the surface symmetry and lattice parameter of the desired materials—i.e., how well the LEGOs will "lock."

The elements, however, aren't really the starting point. When Lee is considering what kind of materials he wants to develop, he begins by thinking where he'd like to end up. First, there's the physics he wants to pursue (for example, topological superconductivity). Then he searches for the most promising materials candidates that might realize this physics (say, a superconductor-semiconductor hybrid system). As he narrows down potential materials that fit with his MBE expertise, he keeps in mind the current challenges of the field, what the next experimental milestones will be, the design and fabrication of devices to address those goals, and ultimately, measurements that demonstrate the quantum phenomena he's looking for are actually there.

> "I would like to interface dissimilar materials based on my expertise as well as other researchers' expertise to synergistically create new functionalities."

Lee's research is based at the UT-Oak Ridge National Laboratory Joint Institute for Advanced Materials, which provides a collaborative environment to combine his strengths with those of other UT physicists.

"I would like to interface dissimilar materials based on my expertise as well as other researchers' expertise to synergistically create new functionalities," he said.

For example, he could grow an indium arsenide semiconductor to interface with a high-temperature superconductor grown in Hanno Weitering's group. This would allow them to study topological superconductivity that can be induced at much higher temperatures compared to currently studied materials systems. Another example he proposed would be that his group could prepare superconductor-semiconductor systems to grow on magnetic materials created by either Jian Liu's or Haidong Zhou's group. Such a material could exploit internal magnetic coupling to induce topological superconductivity without applying an external magnetic field. Grown materials can be carefully characterized in Norman Mannella's group, and materials characteristics and physics behind the superconducting/magnetic features can be further understood with the help of our condensed matter theory groups.

Lee will also participate in the Appalachian Quantum Initiative, an endeavor that leverages the resources of the university and its partners to strengthen regional research and education.

Just Past the Starting Line

While he started at UT in January, Lee's MBE equipment didn't arrive until late October.

"I just left the starting line of my research," he said.

(Though for someone who just left the starting line, he's doing quite well, having been recognized with the 2020 Outstanding Young Researcher Award by the Association of Korean Physicists in America.)

Once all equipment is installed, his group, including graduate students Pradip Adhikari and Anjali Rathore as well as undergraduate Lena Schwebs, will start growing and characterizing materials—semiconductors, superconductors, and hybrids of the two. As they progress to developing and testing devices, he'll be looking for more help.

"My group will need more hands and brains," he said. "Highly motivated undergraduate and graduate students are always welcome."

Lee's other students were those enrolled in his thermal physics course this past spring, an interesting semester that began in the classroom and ended online.

"My teaching in spring 2020 was full of challenges and fun," he said. "Everything was new, from developing face-to-face teaching schemes to transitioning to online teaching."

When the term began, Lee said he was using a whiteboard to write down equations and a projector to show slides with figures. When the class moved online after spring break, there was some trial and error to find the best approach, which turned out to be a OneNote page with blank spaces between figures for taking notes during class.

"I thank all the students who actively participated in both the offline and the online classes and provided feedback to improve the class," he said.

When he isn't studying quantum materials or developing physics courses, Lee loves playing with his kids, ages three and one. He does let science carry over to his leisure time just a bit, though not with the precision his nanostructures demand. When it comes to books and movies, he's a science fiction fan.

He Always Made Time

He has patiently guided countless undergraduates through advising sessions and helped shape the department's curriculum. He has devoted hours to professional development for math and science teachers at the middle school and high schools level to strengthen the pipeline to college physics programs, earning the 2005 Chancellor's Citation for Excellence in Academic Outreach. And he has navigated the Tennessee Science Olympiad probably more times than he can count. After four decades with the university, Professor Stuart Elston retired in 2020.

Elston earned a BS in physics from the Rochester Institute of Technology in 1968. Following two years of service in the United States Marine Corps, he completed a PhD in physics at the University of Massachusetts at Amherst in 1975. That same year he came to the UT Physics Department as a postdoctoral research associate, joining the faculty in 1979. He was also an adjunct research and development participant with the Oak Ridge National Laboratory Physics Division from 1979 to 1996.

In the late 1990s Elston's research interests evolved to physics and science education, partially in response to a nationwide drop in graduating BS physics majors to pre-Sputnik-era levels. Among his long list of contributions in this area was the design and implementation of Teach/Here, a teacher residency program that trained and certified career-changing math and science professionals and middle and high school math and science teachers. He was co-principal investigator on this National Science Foundation Grant, a $1.9 million initiative to improve STEM education in Tennessee. Elston also served as a higher education representative on Tennessee's State Leadership Team for the Next Generation Science Standards on the state board's K-12 Science Standards Review Team.

For UT's physics majors, however, Elston's primary influence came as adviser and teacher. He was instrumental in implementing the Studio Physics teaching paradigm in the department. He served as the undergraduate academic advising coordinator, as well as the undergraduate program director. In 2016 he was awarded the College of Arts and Sciences Faculty Advising Service Award, in part for his commitment to meet with every incoming physics major to discuss their specific interests and determine their level of preparedness. He consistently taught Physics 135-136, the introductory physics course for physical science and math majors, as well as the electronics laboratory, and it was there he made an indelible impression on so many students. Twice, including this year, he won the UT Society of Physics Students Teacher of the Year Award. And it is, perhaps, the students who draw the most vivid picture of Elston and his commitment to their education.

Last year's SPS President, Lucas McClure, took Physics 135-136 with Elston and shared why he was the choice for Teacher of the Year:

"During that class sequence he made sure each student had a chance to ask questions, and he consistently made his best efforts to ensure we all understood the material through hosting review sessions, holding office hours, and being highly-responsive to e-mails. He had a noticeable devotion to the undergraduate program, both as an undergraduate adviser and as a professor."

Alumnus Richard Manley (BS 2001, MS 2003) still draws on lessons he learned from Elston in his work as a Research Scientist at the Naval Surface Warfare Center in Panama City, Florida.

"Dr. Elston was one of my favorite professors out of some really good professors in the physics department," he wrote. "He always made time for me in or out of the classroom to answer any question I had. I am still using things I learned from him. A couple of weeks ago I was debugging an electrical system using information and techniques I learned in his class and in front of the white board in his office. I am very aware and thankful for the contributions he has made to my career."

Keeping Things Running

Chloe Miller joined the physics department in early February as our travel assistant, following Maria Fawver's retirement. Before moving to physics she was an Accounting Specialist I working directly for Robert Chance, Executive Director in the Treasurer-Payroll Office. When COVID-19 limited travel, she stepped up to help with other responsibilities, taking advantage of her experience with IRIS, the university's resource planning system. A born and raised Tennessean, Miller is a graduate of Pigeon Forge High School and has taken classes at Walters State Community College. She enjoys photography and as well as snowboarding, swimming, and surfing. Her philosophy is "communication is the most important part of any position," and she has been a welcome addition to the front office, where she works with Showni Medlin-Crump and Chrisanne Romeo to keep administrative affairs running smoothly, no matter the circumstances.


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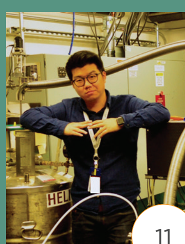

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PHYSICS HONORS DAY

This year there was no gathering in the SERF auditorium to hear the names called out. No invited talk from a distinguished alumnus; no reception. Yet the accomplishments of physics students (and faculty) were in no way diminished by the unusual circumstances. The news came electronically and was shared through social media, but the Honors Day awards were in many ways the same as they have always been—a celebration of scientific creativity, academic excellence, and extraordinary service to the department.

1) Outstanding First Year Student: **Lucas McBee**
2) Robert Talley Award for Outstanding Undergraduate Research: **Ian Cox**
3) Robert Talley Award for Outstanding Undergraduate Leadership: **Lucas McClure**
4-5) James W. McConnell Award for Academic Excellence: **John (Jack) Roberts and David Pochik**
6) Douglas V. Roseberry Award: **Christal Martin**
7) Robert W. Lide Citation: **Tara Skiba**
8-9) Outstanding GTA Award: **Namila Liyanage and Logan Hoskins**
10) James E. Parks Award: **Andrew Shore**
11) Paul H. Stelson Fellowship for Beginning Research: **Xin Wen**
12) Paul H. Stelson Fellowship for Professional Promise: **Josh Barrow**
13) Fowler-Marion Award: **Bryant E. Walker**
14) Society of Physics Students Teacher of the Year Award: **Professor Stuart Elston**

Read details about each honoree at: **www.phys.utk.edu/news/2020/honors-day/**

CHANCELLOR'S HONORS

The Chancellor's Honors, another spring tradition for the university, was virtual this year, but the physics department was well-represented with these campus-wide awards.

Extraordinary Professional Promise

These honors are awarded to undergraduate and graduate students who demonstrate professional promise in teaching, research, or other contributions. Physics students recognized were: **Josh Barrow, Xingfu Du, Charles Hughes, Nitin Kaushal, Christal Martin, Kyle Noordhoek, Jack Roberts, Benjamin Smith, Bryant Walker, Xin Wen, and Junyi Yang.**

Extraordinary Academic Achievement

These honors are awarded to undergraduates who exhibit extraordinary scholarship. Physics students recognized were **David Pochik and Jack Roberts**.

Professional Promise in Research and Creative Achievement

These honors are bestowed on faculty members who are early in their careers and have exhibited excellence in research, scholarship, and creative achievement. **Steven Johnston**, associate professor, was among this year's honorees. He studies the properties of novel quantum materials using state-of-the-art computational methods.

GRADUATE STUDENT SENATE AWARDS

For the fourth year, the Graduate Student Senate (GSS) honored outstanding graduate and professional students as well as the individuals whose work is dedicated to supporting them. Physics claimed four honors: two for faculty, one for staff, and one for a graduate student:

Graduate Professor of the Year

Cristian Batista

Graduate Research Mentor of the Year

Raph Hix

GSS Staff of the Year

Chrisanne Romeo

GSS Outstanding Contribution

Chloe Sandoval

Nadia Fomin

Christine Nattrass

Mae Scott

5 SIGMA PHYSICIST AWARDS

Three UT physicists were among the 16 selected nationwide for the American Physical Society (APS) 5 Sigma Physicist Award. The honor recognizes APS members who have been involved with high-impact advocacy activities through the society's Office of Government Affairs.

Associate Professors **Nadia Fomin and Christine Nattrass,** along with Graduate Student (and May 2020 PhD graduate) **Mae Scott**, were selected for their advocacy for the Combating Sexual Harassment in Science Act, including meeting with United States Senators Lamar Alexander and Marsha Blackburn. The bill, which passed the U.S. House of Representatives last July, directs the National Science Foundation to award grants that will expand research into sexual and gender harassment in the STEM workforce and examine interventions for reducing the incidence and the negative consequences of such harassment.

Quantum Entanglements

Professor Adrian Del Maestro Joins the Physics Faculty

Adrian Del Maestro has a unique way of explaining exactly what about quantum science captured his attention. He calls it anti-maple syrup. That may not be the most technical description of superfluid helium, but it's a vivid illustration of how this frictionless phase of matter behaves, and his fascination with such quantum phenomena guides the research program he brought to the physics department this fall as a new professor.

Scientists in the Basement

An appreciation for science was woven into Del Maestro's upbringing in London, Ontario, Canada. His father, Rolando Del Maestro, holds both an MD and a PhD and balanced a neurosurgical practice with a research group studying brain tumors. Though his practice has closed, he's still active in research as an emeritus professor at McGill University and continues to work with the Brain Tumour Foundation of Canada he co-founded.

"I grew up in a highly academic household," the younger Del Maestro said. "We often had postdocs and scientific visitors staying for extended periods of time in our basement. In fact, my first paper was written together with my father when I was an undergraduate."

Del Maestro always had a penchant for science and math and majored in both at the University of Waterloo. It was during his undergraduate studies that he began focusing on condensed matter. He went on to earn two master's degrees in physics (one at Waterloo and a second at Yale University) before heading to Harvard University, where his doctoral research centered on a theoretical quantum phase transition between a superconductor and a metal. Among his postdoctoral research appointments was a stint at the Institute for Quantum Matter at Johns Hopkins University.

Understanding the intricate workings of quantum systems—the entanglement of their constituent particles and how those particles behave in the collective—has long intrigued Del Maestro. Some of the most interesting territory is the potential for new, emergent phenomena, where macroscopic behavior isn't visible at the microscopic level. Among these phenomena are superfluids.

Anti-Maple Syrup

"The one aspect of the quantum world that really got me interested was superfluid helium," Del Maestro explained. "I find the superfluid phase of helium fascinating. This is the only strongly interacting elemental superfluid we know of and it can flow without any viscosity. I like to think of it as the anti-maple syrup."

This "syrup" also shows how the quantum world needn't necessarily be confined to microscopy.

"We usually think of quantum mechanics applying only to the very small; atoms and molecules, etc.," Del Maestro explained. "But you can cool a coffee mug of helium down to 2 K (-271 C) and the entire thing will undergo a phase transition to a superfluid described by a single macroscopic quantum wavefunction. The idea of understanding and potentially exploiting quantum phenomena on this human-sized scale continues to excite me and motivates a large swath of my work."

Quantum systems, however, come with the thorny issue of having multiple subatomic components and a daunting number of interactions, better known as many-body problems.

"The sheer complexity of quantum-many body systems and the exponential number of microscopic configurations that they can take on is the persistent challenge of our field," Del Maestro said. "Even if we can write down a complete description describing all interactions, we can often only gain insights into the behavior for a few particles or in very special situations."

The rules governing quantum systems can cause headaches for theorists. This is especially true for fermionic wavefunctions (electrons, or say Helium-3) where interactions and motion can cause the emergence of negative signs that prevent simulation on classical computers. Still, Del Maestro said that in some cases they may be able to find techniques or algorithms to work around this "sign" problem.

"Searching for such tricks is an important part of what we do and finding them immediately opens up new areas of research and potentially a path towards novel technologies," he said. "Pursuing this research has led to the development of tools that utilize high performance computers to simulate the quantum world. This is the ultimate theoretical platform where we can search for the answers to curiosity driven questions."

A Deep Bench of Expertise

Before joining UT Del Maestro spent nine years on the physics faculty at the University of Vermont (UVM). He also served two years as the director of the Vermont Advanced Computing Core (VACC), which provides large-scale advanced computing resources to UVM researchers. That experience, coupled with his own research, made clear to him the critical role these resources play in contemporary science.

"Access to high performance computing and all the supporting advanced cyberinfrastructure is as important to modern science as brick and mortar infrastructure," like labs and fume hoods," he said. "Removing limits on computing access allows researchers to attack problems that were previously deemed 'too difficult' and more importantly, engage in rapid feedback loops that advance science in new and unpredictable ways."

As the VACC director he saw firsthand how high-performance computing is an area where researchers "walk-the-walk" of multi-disciplinarity. Tools can be shared quickly between different research areas, especially with open source software. His experience with advanced computing and shared expertise fits well with Del Maestro's role in UT's cluster in quantum materials, part of a university initiative to make strategic hires in areas that will benefit Tennessee and the wider world.

"The quantum materials cluster intends to attract a critical mass of researchers that can work closely together to solve broad and deep challenges on how we can leverage quantum mechanics and materials science to build future technologies in aid of societal goals," he said. "UT is the perfect place for this endeavor, with a very deep bench of existing expertise in this area, and the support from the administration in realizing the clusters vision has been impressive."

Del Maestro's position is a joint appointment with Min H. Kao Department of Electrical Engineering and Computer Science, which is a natural fit given his computing background, and he is actively engaged with his colleagues there. He's also had many discussions with Physics Professor George Siopsis about the Appalachian Quantum Initiative, an interdisciplinary team devoted to leveraging university and partner strengths in quantum computing and supercomputing.

Asking Big Questions & Sharing the Toolbox

As computing becomes more sophisticated, so too do possibilities for solving quantum puzzles.

"I try to ask big questions and then focus on the parts that are standing in the way of an answer," Del Maestro said.

One of his current obsessions is that in quantum mechanics, like things are indistinguishable.

"Access to high performance computing and all the supporting advanced cyberinfrastructure is as important to modern science as brick and mortar infrastructure."

"There is no experiment that you can perform to distinguish between two electrons," he said. "So a natural question arises, can we do something with this non-classical facet of the world? Is there useful entanglement encoded in the many-body phases of quantum matter made up of identical constituents? If so, can we measure it? Can it be tuned and optimized? Can we extract it? Following my nose down paths like this yields more research problems than I have time to answer."

When he does set out to tackle a problem, Del Maestro starts with a literature review to assess the state of the field and see what's already been tried.

"The hope is that one of the tools in our arsenal can be applied to the problem and that our experiences can add something to the field," he said.

That was the case with work his group published in *Nature Physics* a few years back about their studies on entanglement in superfluid helium.

"While people had previously studied the area law (the fact that entanglement entropy has fundamentally different behavior than thermodynamic entropy) in simple models of magnetism, we demonstrated this behavior in experimentally realizable quantum liquid," he explained.

"The connections between this entropy 'area law' and the one made famous for black holes by Stephen Hawking led to the paper receiving a lot of interest" (including an Altmetric score of 202, putting it in the top five percent of all measured research).

As firm believers in open science, his group made all code and data from the project available to other scientists. It has since been used for research outside their involvement, something Del Maestro calls "a very exciting outcome in terms of the famous ideas of Eric Raymond's *Cathedral and the Bazaar*: 'given enough eyeballs, all bugs are shallow.'"

"I love teaching computational physics because it is amazing to see the empowerment of junior physicists when you provide them with the tools of high-performance scientific computing."

This idea of sharing tools and knowledge will be front and center for the spring 2021 term, when Del Maestro will teach a new course called "Introduction to Machine Learning for Scientists."

"I love teaching computational physics because it is amazing to see the empowerment of junior physicists when you provide them with the tools of high-performance scientific computing," he said. "I'm excited to convey how the tools of artificial intelligence can be applied to modern problems in physics."

He hopes to add more students to his research group, which includes graduate student Emanuel Casiano-Diaz (who came from UVM) and postdoc Dr. Hatem Barghathi.

Not everything in life, of course, is quantum entanglement, and Del Maestro has plenty of interests outside the world of algorithms. An avid sports fan, he's on the lookout for a post-COVID lacrosse team to join. He insists, however, that his wife Caitlin, a project manager in public health education, is better at all sports than he is ("You should see her pull the ball to right field"). Eventually he'd like to translate his love of sports into a new course like one he developed for freshmen at UVM, where students learned how Bob Beamon held the long jump world record for 23 years and why a curve ball curves or a knuckle ball dances.

He and Caitlin also have a family with "two amazing daughters and an American Staffordshire terrier named Cooper (yes, after BCS theory)."

Even though moving to a new university in the middle of pandemic can be a formidable undertaking, Del Maestro is optimistic about what the future holds.

"I'm incredibly excited about the opportunity to move my research and teaching to UT and interact with the amazing people in Physics and Astronomy and the Min H. Kao Department of Electrical Engineering and Computer Science," he said. "Everyone has been so welcoming and supportive thus far and I can't wait to see how the Quantum Materials for Future Technologies cluster positions the University of Tennessee as a global leader in the field."

Strengthening the Physics Community

As a science, physics has more than enough room to include supernovae as well as quarks. It's fitting, then, that the department has written a plan to ensure a welcoming place for everyone who works, studies, and visits here and to create a vibrant academic environment that encourages a diverse community. The Diversity Plan Task Force began working in 2018 to review the department's climate and map out strategies for improvement. They reviewed university initiatives and resources as well as those from other institutions; requested feedback from faculty, staff, and students; and listened to colleagues, guest speakers, and visitors with experience in diversity issues and opportunities. In June 2020 the faculty unanimously approved the plan resulting from that work, which outlines four main goals:

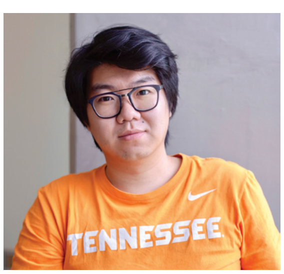
- Create and sustain a welcoming, supportive, and inclusive campus climate.
- Attract and retain greater numbers of individuals from historically underrepresented populations into the undergraduate program.
- Attract and retain greater numbers of individuals from historically underrepresented populations into the graduate program.
- Attract and retain greater numbers of individuals from historically underrepresented populations as staff and faculty.

To meet these goals the department established a permanent community committee comprising faculty, staff, and student representatives. The committee will work with the department head on all aspects of departmental climate, inclusion, and diversity and to make sure the plan is successfully implemented. The diversity action plan is available at: **www.phys.utk.edu/about/diversity-action-plan-2020.pdf**

Physics Students win Three Science Alliance GATE Awards

Rajesh Ghimire

Adrien Green



Xin Wen

The UT Science Alliance has long supported graduate students through assistantships and fellowships, and three physics graduate students are among the 2020-2021 class of Graduate Advancement, Training and Education (GATE) program awardees. The initiative helps strengthen meritorious, collaborative research between the university and Oak Ridge National Laboratory. GATE awardees receive a 12-month appointment, including a stipend, tuition waiver, and health insurance.

Rajesh Ghimire's research focuses on instrumentation development, data acquisition, and analysis of large data sets to better understand nuclear reactions. An understanding of nuclear reactions can lead to developing an understanding of nucleosynthetic processes in deep cosmos. Rajesh hopes to use this work to expand his expertise in experimental nuclear physics.

Adrien Green's work centers on the development of secure quantum communications, or the introduction of the laws of quantum mechanics into encryption to develop more secure means of communication. He hopes his work will contribute to the innovation necessary to make such technology widely accessible to the greater public.

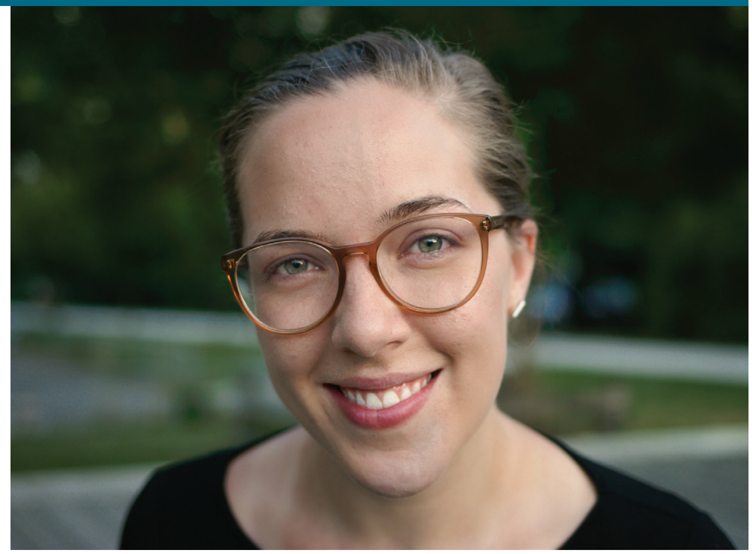
The study of turbulence has implications in an array of real-world scenarios, from transportation to medicine. **Xin Wen's** research seeks to effectively quantify and test turbulent flow through the use of liquid helium. He plans to engage in multiple collaborations on this work, including with ORNL, the Joint Institute for Computational Studies, and the National High Magnetic Field Laboratory.

(*Courtesy of UT Science Alliance*)

A Role for Everything

Introducing Tova Holmes, Assistant Professor

Any new job requires a certain element of adjustment. For Tova Holmes, that's meant working an ocean away from her colleagues at UT and meeting her students over Zoom. Yet she views this less as a challenge than an opportunity. Holmes, who joined the faculty this fall as an assistant professor, has always been interested in finding the role every piece plays to fill out the larger picture.



In that vein, she sees her current situation as the best of both worlds for a new faculty member. Living in Switzerland this fall kept her close to research at the Large Hadron Collider (LHC) while teaching and attending meetings, albeit virtually, in Knoxville.

Seeking connections is hardly new for Holmes. Growing up on a small mountain on the outskirts of a New York City suburb, she said she loved to learn how natural systems and creatures evolved to coexist. She had nurturing influences at home and at school who encouraged that curiosity.

"There were great public schools in my town, with excellent science and math teachers, who got me interested in science from an early age," she said.

Her parents shared this enthusiasm for the natural world. Holmes described how her father could walk through a forest and explain each organism's role, inspiring her to follow his example. Her mother lobbied the local Audubon Society to sponsor Holmes' trips to nature camps in the summer. Programs at Columbia University's Lamont Doherty Earth Observatory and a "particularly excellent teacher," as she explained it, drew her to Earth science and astronomy.

"I loved seeing the translation of simple math to the physical phenomena around me—the tides, the seasons, the weather," she said.

Those interests became more pronounced during her undergraduate studies at Harvard University, where she majored in both physics and astronomy/astrophysics and won a fellowship through the Harvard College Research Program.

"By that point I had decided that I liked thinking outside of the human scale—really large or really small—because both help us access the most fundamental parameters of the universe," she said.

Supersymmetry Searching

After exploring a few research avenues, Holmes found that particle physics was her primary interest after joining the ATLAS experiment. ATLAS is one of two detectors at the LHC and has been part of the search for the Higgs boson, as well as dark matter.

"I loved working in a huge experiment where my successes impacted many people, and where communicating and collaborating was a big part of my job. I liked coding, and figuring out how best to visualize problems with data. And of course, I liked that my job was searching for new fundamental physics," she explained.

She stayed with ATLAS through her doctoral program at the University of California, Berkeley, and on to a prestigious Robert R. McCormick Postdoctoral Fellowship with the University of Chicago. With her new faculty position, Holmes is moving from ATLAS to another LHC detector: the CMS (Compact Muon Solenoid) experiment. The CMS program has the same scientific goals as ATLAS but pursues them with different tools and designs. For Holmes, the intrigue of working with these experiments lies in searching for new particles—specifically long-lived particles.

Holmes' expertise lies in searching for supersymmetry, a framework that describes the subatomic landscape more completely by predicting a partner for each particle in the Standard Model. She uses hardware systems to recognize patterns and track the footprints of possible candidates, an undertaking she describes as a “computationally intensive operation,” with the added challenge of collecting data in real time.

“Normally, LHC searches assume that if we produce a new particle, it will immediately decay into familiar particles, like electrons and quarks, and that if we measure these familiar particles, we can reconstruct that short-lived new particle,” she explained. “I’m interested in cases where the new particles have macroscopic lifetimes, and leave unconventional signatures in our detectors. Right now I’m working with theorists and people across both ATLAS and CMS to figure out how we can better search for these scenarios.”

Holmes led the commissioning team for a hardware tracker at ATLAS and is now transferring her skills to the CMS. That experience coincides with CERN’s scientific needs, as upgrades to the High-Luminosity Large Hardon Collider project require a good deal of research and development, as well as commissioning work. She would love to have interested students join the endeavor, despite the hurdles COVID-19 has presented for the research program.

“At CERN, operations are slowly ramping back up, with lots of safety precautions,” Holmes said. “Face shields and N95 masks are required for anyone working in close contact, and CERN has even started producing its own hand sanitizer and distributing it to us. It’s an unusual and stressful time to be doing just about anything right now, but for my particular situation there is an upside: I can work both with my experiment here in Switzerland and join in all the UT activities remotely.”

Mentorship and OScope Music

Holmes taught Physics 221 for the fall semester and will teach it again in the spring. She has an obvious appreciation for the importance of teaching and mentorship, drawing on her own experience.

“I had a lot of really excellent mentors as I went through my physics education, and I don’t think I would be a professor now without them,” she said. “Mentoring is one of the most effective tools we have at the individual level to improve equity in physics, and in particular, to support students who have already decided that physics is where they want to be.”

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She is also a big proponent of outreach, having previously hosted a podcast on what life is like for a particle physicist to give listeners a way to imagine themselves in the role. And then there’s her involvement with ColliderScope, a program that turns oscilloscopes into musical instruments to showcase the sounds of the Large Hadron Collider. Her partner, Lawrence Lee, leads the program and stars as the performer, while Holmes is the project producer, working on show design and image creation.

“We’ve had shows at clubs and music festivals, where people who would never attend a science fair get to enjoy a show, and if they like, think a bit more deeply about the physics of sound,” she said. “The goal of ColliderScope is to increase the number of people in the world who find physics interesting—and of course to put on a good show.”

Music is one of Holmes’ many avocations. She and Lee roam the Swiss mountains with their rescue dog, hunt for mushrooms in season, and spent their free time this summer swimming in Lake Geneva. She’s also part owner of a Massachusetts-based brewery called Aeronaut. Interestingly enough, another of her passions might have kept this young faculty member—who was chosen for a Rising Stars in Physics Workshop at the Massachusetts Institute of Technology—out of physics. As a kid she loved painting and at one point considered going to art school.

“Ultimately,” she said, “I decided I’d rather be a scientist with a painting hobby than a painter with a science hobby.”

Grad Students win Three SCGSR Awards

Condensed matter systems and matter-antimatter asymmetry; quantum computers and cryogenic magnets; high-momentum nucleons from short-range interactions—these are the studies and tools **Trevor Keen, Kavish Imam, and Casey Morean** will tackle with support from the US Department of Energy via the Office of Science Graduate Student Research (SCGSR).

The SCGSR program prepares graduate students for careers in science, technology, engineering, or mathematics that align with the DOE's mission. Students who win funding through the program have thesis research opportunities working with scientists at DOE national laboratories. Both Keen and Imam will be working at Oak Ridge National Laboratory (ORNL). Morean, whose award was part of the spring cohort, will work at Thomas Jefferson National Accelerator Facility (TJNAF), or JLab for short.

Keen began working with Associate Professor Steve Johnston in the spring of 2018. His SCGSR grant will support research in the development and deployment of simulations for condensed matter systems using quantum computers. He will implement and test quantum-classical algorithms to take advantage of quantum resources (qubits) to solve the Hubbard model, a tool scientists use to work out "electron hopping" in transitions from metal to insulator.

Imam will be working with the nEDM@SNS experiment at ORNL, which aims to search for new sources of time-reversal and charge-parity symmetry violations necessary to explain the observed matter-antimatter asymmetry of the universe. Headquartered at the Spallation Neutron Source on the Fundamental Neutron Physics Beamline, the experiment uses a cryogenic magnet to provide the magnetic field environment required to achieve the necessary and sensitive measurements. Imam has been working with Associate Nadia Fomin and Professor Geoff Greene (who holds a joint appointment at ORNL) since the fall of 2017.

Fomin is also adviser to Morean, a fourth year student whose research is at JLab—home to the Continuous Electron Beam Accelerator Facility (CEBAF), a powerful and continuous electron beam with energy up to 12 billion electron volts supporting experiments designed to explain the fundamentals of matter. Morean is preparing for and running an experiment to measure high-momentum nucleons that come from short-range interactions.

SCGSR awards provide support for travel to and from national laboratories, as well as a monthly stipend of up to $3,000 for general living expenses while at the host laboratory. UT is squarely in the top three institutions in the nation for success in securing funding from this program.

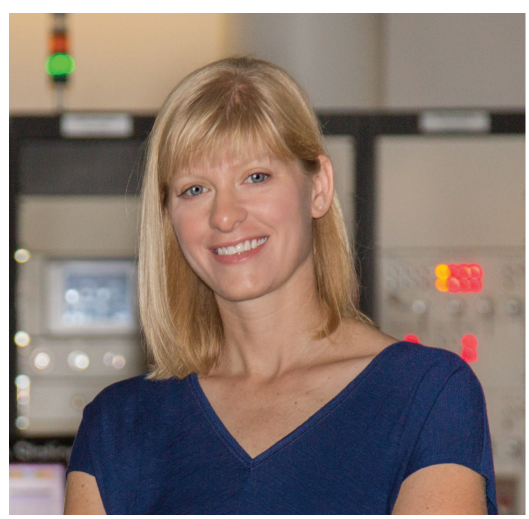
Trevor Keen

Kavish Imam

Casey Morean

Sarah Cousineau Named a Fellow of the APS

Joint Faculty Professor Sarah Cousineau was named a 2020 Fellow of the American Physical Society "for high-impact contributions to high-power proton accelerator research, inspiring workforce education and effective leadership in the physics of beams." She is Section Head for Accelerator Science and Technology at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory, where she has mentored undergraduate students and advised physics graduate students and postdocs. She serves as an interface between the university and the SNS for research and graduate education. Fellowship is an honor signifying recognition by one's peers. Each year, no more than one half of one percent of APS membership is elected for fellowship status. (Image courtesy of ORNL)



Geoff Greene Wins Prestigious Bonner Prize from APS

Geoff Greene's lifetime is inextricably linked to that of the neutron. His tireless pursuit of this scientific mystery—finding out how long a neutron lives and what that reveals about the weak force, the Big Bang, and other fundamentals of science—has earned him the Tom W. Bonner Prize in Nuclear Physics from the American Physical Society.

Greene was recognized "for foundational work establishing the field of fundamental neutron physics in the US, for developing experimental techniques for in-beam measurements of the neutron lifetime and other experiments, and for realizing a facility for the next generation of fundamental neutron physics measurements." He will accept the award at a ceremony in April.

Greene is the second UT faculty member in the past decade to win the Bonner Prize. Former Professor Witek Nazarewicz claimed the honor in 2012.

Professor and Department Head Hanno Weitering weighed in on Greene's accomplishments: "Geoff not only has an excellent track record in building complex scientific apparatus; he also has a very deep knowledge and profound understanding of the biggest physics questions out there," Weitering said. "This combination of knowledge and skills is a rare treat that has allowed him to set the nation's research agenda in the field of fundamental neutron physics. We are thrilled with this extraordinary recognition, and are especially proud that now two of our nuclear physics faculty have received the most prestigious nuclear physics prize in the US."

Greene has been following neutrons and building beamlines to study them for decades, from the National Institute of Standards and Technology to Los Alamos National Laboratory to the Spallation Neutron Source at Oak Ridge National Laboratory, where he holds a joint appointment. The US Department of Energy recently published a feature on this research ("The Mystery of the Neutron Lifetime") and he was invited, along with colleague Peter Geltenbort, to write about his work for *Scientific American* in "The Neutron Enigma."

Greene has shared his expertise with the wider scientific community, serving on the Nuclear Science Advisory Committee; as well as in UT's classrooms, teaching courses including Introduction to Quantum Mechanics and Modern Physics. For those efforts, the UT Society of Physics Students named him Teacher of the Year in 2011. In 2016 the university awarded him the Alexander Prize, an honor reserved for superior teaching and scholarship.

Greene earned a bachelor's degree from Swarthmore College and a PhD from Harvard University. Throughout his long career he has been happy to credit others and encourage their success. When he joined the faculty in 2002, he listed hiring young faculty in the field of nuclear physics among his goals. Associate Professor Nadia Fomin was one of those hires.

"I joined the fundamental neutron physics field late in 2007, without knowing very much about it, surprised that Geoff was willing to take such a chance," Fomin said. "I later learned that I was just the most recent of Geoff's recruits, as I kept coming across exceptional physicists that were hired into the field by Geoff in various roles throughout his illustrious career. It's not much of an exaggeration to say that the field exists in the US in large part due to his efforts. I've been extremely lucky to be mentored by such a physics rock star, and I hope to continue his legacy of growing the field and doing first-rate science."

". . . I kept coming across exceptional physicists that were hired into the field by Geoff in various roles throughout his illustrious career. It's not much of an exaggeration to say that the field exists in the US in large part due to his efforts."

—Associate Professor
Nadia Fomin

50 YEARS PHYSICAL REVIEW A·B·C·D

Milestone Papers

The year 2020 marked the 50th anniversary of the four journals *Physical Review A, B, C,* and *D*, and to celebrate the editors put together a selection of milestone papers that announce major discoveries or open up new research avenues in the fields each journal covers (the lists are on the APS website at https://journals.aps.org/about).

Physics faculty members **Thomas Papenbrock** and **Robert Grzywacz** both had papers in the milestone collection for *Phys. Rev. C* (nuclear physics):

Ab initio coupled-cluster approach to nuclear structure with modern nucleon-nucleon interactions
G. Hagen, T. Papenbrock, D. J. Dean, and M. Hjorth-Jensen
Phys. Rev. C 82, 034330 (2010)

First observation of two-proton radioactivity in ^{48}Ni
M. Pomorski, M. Pfützner, W. Dominik, R. Grzywacz, T. Baumann, J. S. Berryman, H. Czyrkowski, R. Dąbrowski, T. Ginter, J. Johnson, G. Kamiński, A. Kuźniak, N. Larson, S. N. Liddick, M. Madurga, C. Mazzocchi, S. Mianowski, K. Miernik, D. Miller, S. Paulauskas, J. Pereira, K. P. Rykaczewski, A. Stolz, and S. Suchyta
Phys. Rev. C 83, 061303 (2011)

In *Phys. Rev. D* (covering particle physics, quantum field and string theory, gravitation, cosmology, and particle astrophysics) UT was represented by **Professor Stefan Spanier, former Postdocs Keith Rose and Zongchang Yang, and Graduate Student (now PhD alumnus), Andrew York** as part of the CMS Collaboration with the paper:

Measurement of the properties of a Higgs boson in the four-lepton final state
S. Chatrchyan et al. (CMS Collaboration)
Phys. Rev. D 89, 092007 (2014)

In other APS journal news, **Professor Hanno Weitering** was named an APS Outstanding Referee for 2020. This highly selective program recognized 147 referees for the year based on the quality, number, and timeliness of their reports. Honorees came from more than 50 countries and were chosen without regard for APS membership status or their respective fields of research.

When Slater Meets Mott

Born five years and an ocean apart at the turn of the 20th Century, both John Slater and Sir Nevill Francis Mott were known for their contributions to understanding electronic structure (Mott would win a Nobel Prize for his work in 1977). Here in 2020, **Assistant Professor Jian Liu** and his research group studied the crossover regime of insulators named for these physicists, with the results published in *Physical Review Letters*.

In this work, physicists grew a "superlattice," alternating repeating layers of $SrIrO_3$ (strontium, iridium, and oxygen) and $SrTiO_3$, (strontium, titanium, and oxygen) as one unit on three different substrates, or base layers. They were able to tune the electrons in this system through epitaxial strain—essentially compressing the superlattices as they grew them. **Graduate Student Junyi Yang** was the first author on the paper.

Liu is also the recipient of an Office of Naval Research (ONR) Young Investigator award, which recognizes outstanding early-career scientists to encourage their teaching and research. His is the university's first Young Investigator award since fiscal year 2014 and only the third in the past 10 years.

Better Good Than Lucky

Some people, the saying goes, would rather be lucky than good. With results published in *Physical Review Letters*, UT's physicists and their colleagues have shown that creativity and persistence can prove a more rewarding strategy than just waiting on chance. They devised a novel superconductor from the ground up, building on decades' worth of physics discovery and a base of silicon. This system is the first example of modifying a conventional semiconductor and creating a superconductor.

By decorating a boron-doped silicon crystal surface with a very dilute amount of tin—equivalent to only one-third atom layer—the team produced single-atom-thick nanoscale superconducting domains with over 100,000 tin atoms. The structural and compositional simplicity of the tin layer offers not only new insights into superconductivity, but also provides means to integrate superconductors with the all-important semiconductor device platform.

The results were published in *Superconductivity in a Hole-Doped Mott-Insulating Triangular Adatom Layer on a Silicon Surface*. UT Physics authors were **Professor Hanno Weitering, Associate Professor Steve Johnston, and Graduate Student (and 2020 PhD graduate) Tyler Smith**.

Going with the Flow

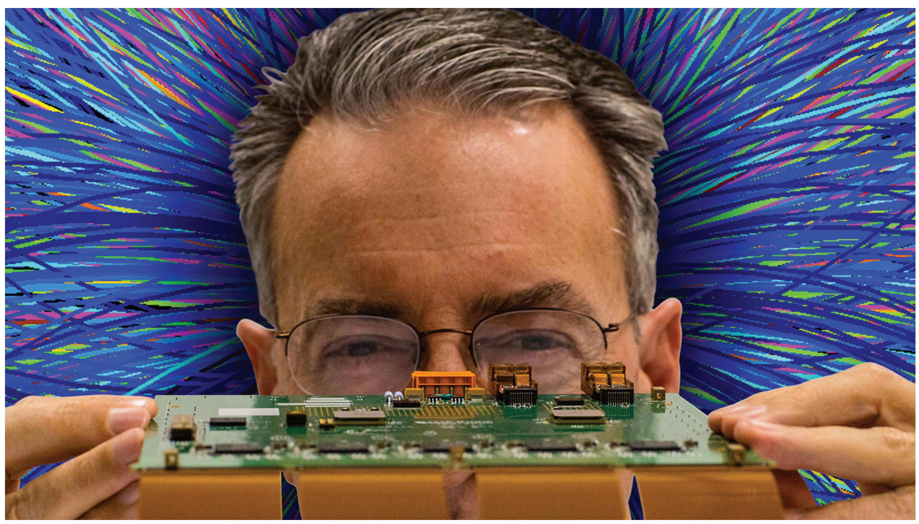
Anyone who has ever flown is probably familiar with the concept of turbulence. Yet understanding turbulent flow—how it develops, its intensity, and its properties—remains somewhat elusive. UT's physicists have helped develop a new technique using excimers created by neutron capture to observe turbulence around macroscopic objects (an airplane, for example, or a ship). Their technique enables measurements of how turbulence behaves over space and time, and can be scaled to work in three dimensions. The work was published in *Physical Review Letters* and was designated an Editor's Suggestion: a designation given to papers the editors find interesting, important, and well-written that would appeal to a broad range of scientists. **Graduate Student Xin Wen** was lead author (he also won a GATE Award to support his research on turbulence, as outlined on page 11). Other UT authors were **Professors Mike Fitzsimmons, Anthony Mezzacappa, and Geoff Greene** (all from physics), along with **Research Assistant Professor Ryan Glasby** (Min H. Kao Department of Electrical Engineering and Computer Science).

UT's Nuclear Physicists Part of Major DOE Quantum Initiative

In August the US Department of Energy announced that the university's neighbor and partner, Oak Ridge National Laboratory, will lead a multidisciplinary collaboration to advance the promise of quantum science in avenues including new materials, algorithms, sensors, and storage. The Quantum Science Center, a $115 million project, supports the National Quantum Initiative Act of 2018 and includes partners from other national laboratories, the private sector, and academia. Among its goals is developing the next generation of scientists and engineers, which is where the physics department comes in. **Physics Graduate Student Chenyi Gu** will be supported through the Center. She finished her undergraduate studies at Ocean University of China before joining the graduate program in 2017, and since 2018 has been working with **Professor Thomas Papenbrock,** who's also part of the ORNL Physics Division.

Streaming a Data Tsunami

Professor Ken Read specializes in nuclear physics and high-performance computing, as evidenced by his leadership of the team that delivered 3,276 circuit boards (with nearly 500 spares) for a major electronics upgrade at A Large Ion Collider Experiment, better known as ALICE. This enormous experiment, located at CERN in Geneva, seeks to untangle the mysteries of the quark-gluon plasma: a primordial "soup" of quarks and gluons present soon after the universe was born.



Ken Read led design, fabrication and assembly of ALICE's upgraded electronics hardware. Background: CERN. Foreground: Oak Ridge National Laboratory, U.S. Dept. of Energy; photographer Carlos Jones, composition Brett Hopwood.

Read's team designed, fabricated, and assembled electronics hardware to process streaming data — in real-time — at a rate of 3 terabytes per second. The work was part of a major multi-year upgrade for ALICE done with partners including Oak Ridge National Laboratory, where Read holds a joint faculty appointment. The work was highlighted on the DOE Office of Science website, with additional insights from **UT Physics/ORNL Joint Faculty Professor** and upgrade project director **Thomas Cormier. Professor Soren Sorensen** and **Graduate Students Andy Castro, Charles Hughes, Austin Schmier, and Will Witt** made important contributions to the project.

Understanding the Great Divide

Bacteria, through no fault of their own, often have a public relations problem. People are quick to see them as a cause for illness. Soaps, hand sanitizers, and cleaning products are marketed on the promise of eliminating them. Yet any one person's digestive system can have up to 100 trillion bacteria comprising a mix of mostly good and some not-so-good characters. Most strains of *Escherichia coli* (*E. coli*) —like those in the human digestive tract—are safe and even helpful. Understanding how these cells divide can help develop better antibiotics, provide a blueprint for synthesized enzymes, and tell scientists more about how phase transitions occur—a fundamental concept in physics. UT's biophysicists used high-resolution imaging tools to get a clearer picture of what prompts these bacterial cells to split in two. They published the findings in the February 3 issue of *Current Biology.* **Bryant Walker,** a physics graduate student, was the lead author, joined by **Associate Professor Jaan Männik and Research Scientist Jaana Männik**.

Keep Looking Up

Space Science Outreach Director Paul Lewis reminded us all that even if we were spending more time at home, it's always a good idea to look up. Throughout the year he has shared his astrophotography via the department's social media accounts, including the image above from early April showing the conjunction of Venus with the Pleiades. Lewis wasn't the only UT astronomer to share his work. Below is a photo of Comet NEOWISE taken by **Instructor/Astronomy Program Coordinator Sean Lindsay** from Foothills Parkway (US 129) on July 9.

The Founding Father of JIAM

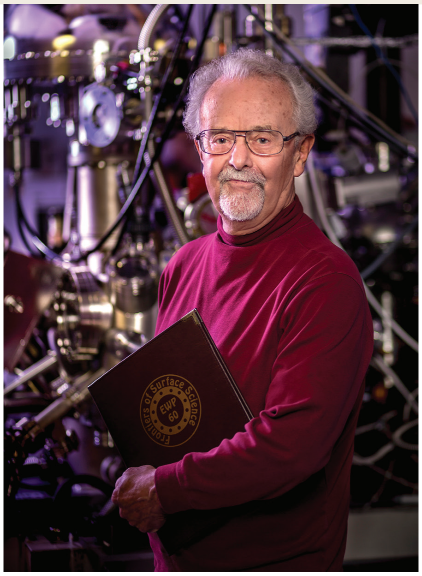
Remembering Ward Plummer

Ward Plummer—the inspirational and always colorful physicist who came to UT from Penn as part of the Distinguished Scientist Program—passed away July 23 at his home in Baton Rouge, Louisiana. He held a joint appointment at UT and Oak Ridge National Laboratory from 1992 until 2009 as a Distinguished Professor at the university and a Distinguished Scientist at the national laboratory. He was the founding Director of the Joint Institute for Advanced Materials and a member of the National Academy of Sciences. His seemingly inexhaustible curiosity inspired a long scientific career punctuated by numerous grants, awards, and papers, but his mentorship was—in his opinion—the crowning achievement of his work.

Plummer was born in October 1940 and grew up in Warrenton, a small fishing and timber town near Astoria, Oregon. He earned a bachelor's degree in physics and math at Lewis and Clark College in Portland before moving to Cornell University, where he completed a PhD in 1968. He then joined the National Bureau of Standards (now NIST) as a postdoctoral fellow and after three years became Assistant Section Chief for Surface Physics. Plummer moved to the University of Pennsylvania, joining the faculty in 1973. He rose to the rank of professor and served as Director of the Laboratory for Research on the Structure of Matter, home of an NSF-funded Materials Research Laboratory (currently called MRSECs). In March 1992 he was named a Visiting Distinguished Scientist at ORNL, and in December of that year he came to UT as a Distinguished Professor of Physics through the Science Alliance program.

Plummer was a dedicated scientist with a brilliant career in surface science. He pioneered the use of surface science analytical tools such as field emission spectroscopy, angle-resolved photoemission and electron energy-loss spectroscopy. He discovered the multipole plasmon mode localized at the surface of a "simple" metal, a finding that is currently of great interest in the field of nano plasmonics. His relentless drive in the pursuit of science led him to push for development of the Tennessee Advanced Materials Laboratory (TAML), which opened in 2001 as a UT Research Center of Excellence. He was a staunch advocate for the project, believing that materials—particularly in reduced dimensions—would be a major driver for science and engineering in the future. In 2005, with Plummer among the loudest of cheerleaders, the university and ORNL won $30M in federal and state funding to build a new building on UT's campus, designed to foster those initiatives. It would be called the Joint Institute for Advanced Materials, and it was TAML's direct descendant.

In 2009 Plummer left UT to join Louisiana State University Physics Department as the Boyd Professor and was also special assistant to the Vice Chancellor of Research. There, he helped build collaborative research and education programs between the US and international partners, which led to the creation of a dual degree program between LSU and the Institute of Physics in Beijing, China. In 2017, he was awarded the International Science and Technology Cooperation Award of the People's Republic of China. At 79, he was still working.



Over the course of his career, Plummer served on numerous review teams, advisory committees, and editorial boards. He wrote more than 420 refereed papers and had a long list of honors, including: the Wayne B. Nottingham Prize; the Davisson-Germer Prize in Atomic and Surface physics of the American Physical Society; the Humboldt Senior Scientist Award; the Medard V. Welch Award from the American Vacuum Society; and election as a Fellow of the AVS as well as the American Physical Society. He was a member of the National Academy of Sciences as well as the American Academy of Arts and Sciences. He was listed as one of the 1,000 Most Cited Physicists from 1981-1997 and among his papers are one of the top 100 papers published by NIST in the 20th Century. In 2007, Lewis and Clark honored him with the Distinguished Alumnus Award.

Plummer was particularly proud of the Nottingham Prize because it spoke to a deeper motivation of his science. He won the honor in 1968 as a graduate student. Two of his UT students (John Pierce and Joseph Carpinelli) would go on to win it as well. Plummer was quick to consider any untraveled avenue in surface physics and encouraged his students and postdocs to share their ideas. He was fond of saying that his legacy would not be the papers he published or the prizes he won, but the young scientists he guided along the way. Over his five decades as a physicist, more than 100 students and postdocs would call him their mentor. With their successes, his work lives on.

Image courtesy of Louisiana State University/photo credit: LSU Senior Photographer Eddy Perez.

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PAN E01-1060-001-21

Congratulations to all our physics students who showed their adaptability by successfully navigating classes, research group meetings, comprehensives, and doctoral dissertation defenses via Zoom this year. Da Yang, pictured left, worked with Associate Professor Jaan Männik and successfully defended his dissertation in March to become one of our 18 PhD graduates for the 2019-2020 academic year.

CrossSections