University of Virginia
Physics News
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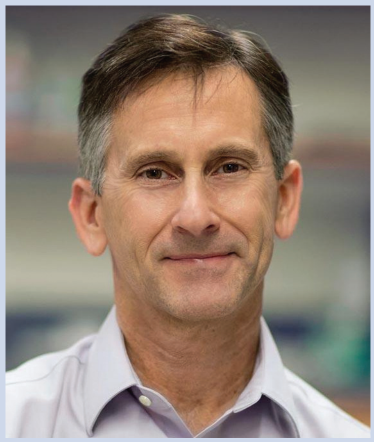
Letter from the Chair



Dear Friends:

Greetings from Charlottesville! The start of the academic year is always an exciting time. Fresh and familiar faces flood grounds, with beginning students (and faculty) anxious to make new acquaintances and start their programs, returning students eager to catch-up with each other and explore new challenges and opportunities, and established faculty invigorated after summer months focused on research. Each year brings change, but the sense of revitalization we experience each Fall is a fundamental constant that we look forward to, and depend upon.

As I write this letter on a (hot) gloriously sunny August morning, I am reminded of the day I arrived on grounds 33 years ago (gulp!), energized and full of anticipation as a first year physics graduate student. This Fall the feelings of expectation are again heightened for me as I begin my term as department chair. These are exciting times, both for the University and the Physics Department. As of August 1, the University has a new president, Jim Ryan. President Ryan has appointed a new provost and a new COO, both of whom will begin their terms in 2019. I am optimistic that the university leadership will have the vision to provide us with new opportunities, enabling our department to advance in the contexts of its research, education, and service missions. Our outgoing chair, Joe Poon, has put the Physics Department in an excellent position to respond to any such opportunities, and we are extremely grateful for his leadership and service over the past eight years.

Big changes are also underway within our department. Planning has begun for a major renovation of our beloved old Physics Building. Although the designs and full scope of the project are in flux, substantial improvements are in store. Picture open collaborative areas, natural lighting, non-traditional learning spaces, and upgraded laboratories. Stay tuned for updates and more details!

With the arrival of Kent Yagi last Fall, the department has added Cosmology and Astrophysics to its list of active research subfields. Kent is already doing great things here. You can learn more about him and his work from the Faculty Profile appearing in this Issue. The number of department faculty in Cosmology and Astrophysics will soon grow as a new faculty search in this area begins this Fall.

The department is witnessing significant faculty personnel changes. First, two new faculty, Assistant Professor Peter Schauss (an atomic experimentalist) and Associate Professor Dmytro Pesin (a condensed matter theorist) will join the department this year. Look for Faculty Profiles about them in the next Newsletter. Second, five long-standing faculty members, Don Crabb, Michael Fowler, Tom Gallagher, Hank Thacker, and Steve Thornton, celebrated their retirements last year. The department is indebted to them for their years of service and wishes them the best of luck moving forward. You can read more about these retirees, including some of their future plans, in this Issue. You can also find career path stories and advice from recent Physics Department graduates, an overview of the successful APS Conference for Undergraduate Women in Physics (CUWiP) organized and held at UVa last winter, and highlights of some current research projects of department faculty.

We hope that you enjoy this update on our department. If you have a moment, we would love to hear back from you and find out how you are doing. Just send an email to phys-chair@virginia.edu, or stop by the department if you find yourself on grounds.

Thanks for reading and for your support of the UVa Physics Department!

Bob Jones
Chair, Department of Physics

New Faculty Profile

Kent Yagi

Kent Yagi, a theoretical gravitational physicist, joined the department in Fall 2017. He completed his PhD at Kyoto University in Japan in 2012. He then moved to Montana State University as a postdoctoral research associate. In 2015, he moved to Princeton University as a JSPS Fellow.

Kent's primary research interests include probing fundamental physics with gravitational waves. This area of research is extremely hot and timely given the first direct detection of gravitational waves from binary black holes made in 2015 and the awarding of the 2017 Nobel Prize to representatives of the LIGO collaboration. Moreover, in 2017, the first direct detection of gravitational waves from a binary neutron star was made in coincidence with associated electromagnetic wave signals, marking the dawn of multimessenger astronomy. Kent used these detections to estimate how well one can probe General Relativity in the strong and dynamical regime that was inaccessible before.

During his postdoc period, Kent discovered unexpected universal relations among certain neutron star observables that do not depend strongly on its unknown internal structure. Probing such internal structure is important to address one of the biggest uncertainties in nuclear physics, namely understanding the nature of nuclear matter. Such universal relations are called the "I-Love-Q" relations and have interesting applications in probing fundamental physics through future neutron star observations.

Here at UVa, Kent's group is working on how we can maximize our ability to use gravitational wave and electromagnetic wave observations from astrophysical compact objects to learn about fundamental physics. For example, he and his student are working on how to constrain or measure nuclear physics parameters directly from gravitational wave observations. Kent is trying to enhance interactions between Physics and Astronomy/NRAO by hosting joint colloquia. He attends journal clubs, seminars, colloquia and group meetings hosted by Astronomy/NRAO and is currently collaborating with some of their faculty.

Kent and his wife, Naomi, were married in July in a traditional Japanese style ceremony. Kent enjoys weekend hikes in Shenandoah National Park with his colleagues.

Female Physics Students Unite at UVa

Martine Lokken

The University of Virginia grounds buzzed with excitement over the 2018 Martin Luther King Jr. weekend as hundreds of female physics enthusiasts came together with shared goals in mind: to foster camaraderie, find inspiration in each other, and look towards the future of the field.

This year was UVa's turn to host one of the annual Conferences for Undergraduate Women in Physics (CUWiP). Sponsored by the American Physical Society, UVa's CUWiP was one of twelve sister conferences held simultaneously across the United States. The conferences aim to cultivate community among female undergraduate physics majors, who earn only ~19% of conferred degrees, a number that has been in decline over the past decade (APS Education Statistics, 2015). The conference was organized by UVa physics professor Simonetta Liuti, as well as a large team of faculty, staff, and students across multiple departments.

A special pre-event, SPIN-UPx, was also held at UVa to promote diversity in Science, Technology, Engineering and Mathematics (STEM). This event, led by Rachel Spraker (Compliance Director for Equality and Affirmative Action at UVa), supported the inclusion of members of racial, ethnic, gender and sexual minorities; students with physical, mental, and learning disabilities; first-generation college students and those from low income backgrounds.

One hundred thirty-nine undergraduates from forty-four colleges and universities across Virginia, West Virginia, North Carolina, Kentucky, Tennessee, Maryland, New Jersey, and even Nova Scotia came to discuss future careers, talk about hot research topics, and forge

See *Female Physics Students* on page 3.

Female Physics Students *(continued)*

new connections. Female graduate students, professors, researchers, lab directors and other professionals were there to give their personal advice on how to succeed in physics.

One highlight of the conference was a morning of laboratory tours. Included were the UVa Physics Department (Condensed Matter Physics: Prof. Despina Louca, Nuclear Physics: graduate student Chris Jantzi, High Energy Physics: Prof. Craig Dukes, Atomic Physics: Prof. Tom Gallagher), a discussion of Nuclear Theory by graduate student Abha Rajan, as well as tours of the Materials Science Department, the National Radio Astronomy Observatory headquarters, and UVA's medical facilities. For example, Dr. Krishni Wijesooriya led a tour of the Emily Couric Cancer Center while teaching students about the physics behind radiation oncology. The group got a sneak-peek at life in the center by meeting staff, examining the technology, and even watching as a patient was imaged by a CT scanner. Dr. Wijesooriya talked about some of her own innovations in the field of medical physics, and encouraged the visitors to "think big": after all, she noted, Marie Curie won not just one, but two Nobel Prizes for her work in physics and chemistry.

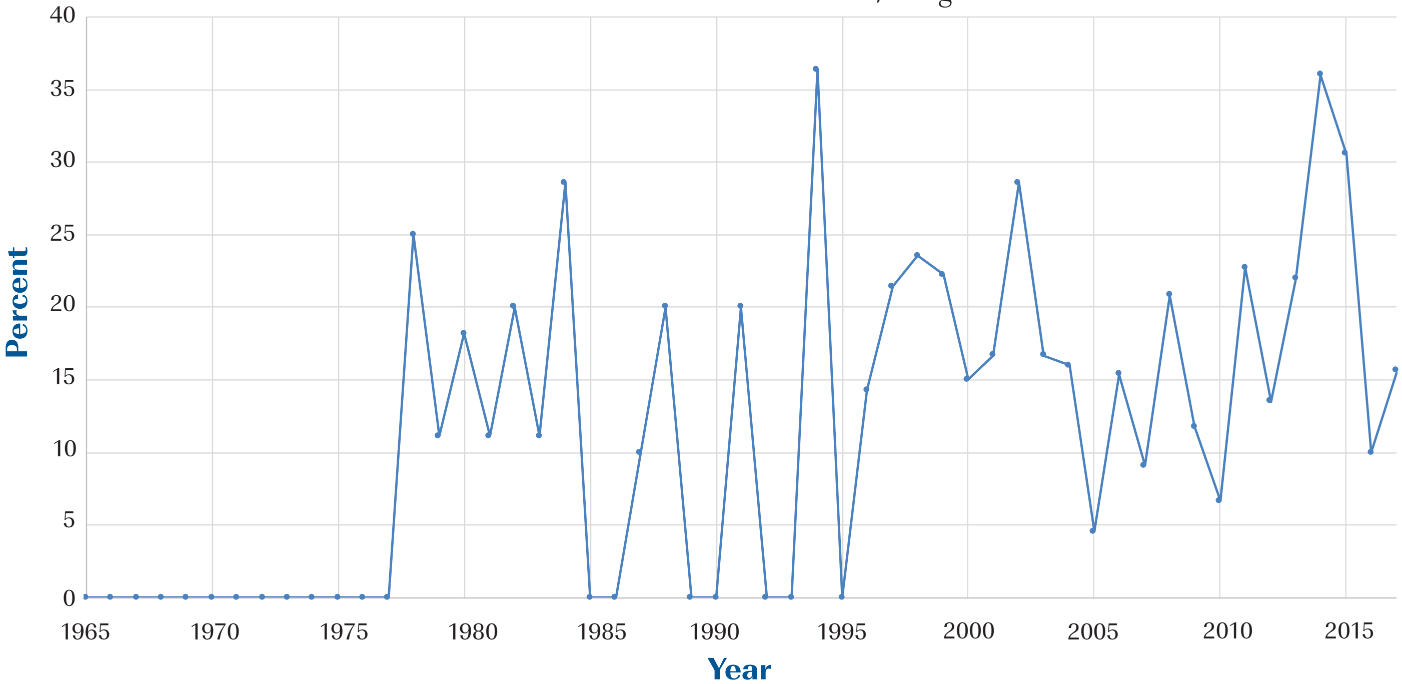
Clearly, the undergraduates were already thinking big, which they proved at Saturday's poster session. Thirty-two research posters were presented, detailing projects in particle physics, biological physics, astrophysics and condensed matter. During the session, not only were the presenters able to improve their research communication skills, but the other attendees also had the chance to learn how to get involved in undergraduate research. The first-place poster prize went to Kayla Callaway of Rowan University for her research entitled "Tunable CdS quantum dots synthesized by reverse micelles."

Saturday morning group photo of Conference attendees taken in the atrium of Bavaro Hall.

See *Female Physics Students* on page 4.

% Women in UVa Physics Undergraduate Class (1965-2017)*

*with available data from 750 out of 1,830 graduates



Percentage of women physics major (BS and BA) graduates at UVa, from 1965 to 2017. Data are available for 750 out of 1830 graduates. (Note: UVa admitted the first women undergrad students in 1970.) Graph made by Rachel Walet (rbw5pf@virginia.edu), class of 2021, Government (major) and Spanish (minor).

Female Physics Students *(continued)*

Other memorable components of the conference included talks by established professionals in physics and astronomy fields. Keynote speakers Prof. Elizabeth H. Simmons (Executive Vice Chancellor, UC San Diego) and Prof. Shohini Ghose (Wilfrid Laurier University) shared their personal journeys and paid homage to great, yet under-recognized, female physicists of the past. Prof. Ghose told the story of Cecilia Payne-Gaposhkin, who discovered that the Sun was primarily composed of hydrogen and helium but whose conclusion was not believed until her male colleagues confirmed the result.

Saturday evening poster session.

Many speakers at the conference shared their own stories of how they overcame challenges. Dr. Kelsey Johnson, who spoke on Saturday, is the picture of success for an astronomer. To name a few of her accomplishments, she has made notable discoveries in the field of star formation, is on the advisory committee for the upcoming James Webb Space Telescope, and teaches highly popular astronomy classes at UVa. At CUWiP, however, she revealed that her path was not easy. Professor Johnson grew up very poor – the "not knowing if there will be heat or electricity or a working toilet kind of poor," she explained. In poverty, and with a single mother, studying astrophysics was not the most obvious of career choices. However, she shared that the hardships in her life made her determined to figure out her place in the universe. Her story clearly struck a chord with the audience. "I loved how she emphasized that through struggle comes great strength, and rather than allowing setbacks or struggles to define you, you can use them to motivate you to do better and be better," said first year UVa physics major Sydney Macon.

On Sunday, CUWiP attendees had a chance to discuss their own successes, setbacks and aspirations in small breakout sessions. These included discussions about coping with imposter syndrome, maintaining a work-life balance, finding research opportunities, and many more. The sessions found a balance between acknowledging the issues facing women in physics fields and developing strategies to achieve career goals, overcome set-backs, maintain a positive attitude and move past difficulties during the course of one's career.

Overwhelmingly positive feedback from both attendees and invited speakers suggests that the conference was a huge success, inspiring and supporting young female physicists across the mid-Atlantic region. Undergraduate students left CUWiP having forged new connections, gained advice, and drawn inspiration from the personal stories of many successful women. Megan Kenny, a second year astrophysics major at UVa, spoke highly of the experience: "I found the conference really empowering in that the talks, discussions, and activities collectively explored the advantages of being a woman in the field as much as the difficulties, showed the spectrum of paths that one can take after a physics degree, and gave us attendees confidence in driving our own careers and making whatever decisions feel right."

After the success of the conference, the CUWiP organizing committee will continue to work towards increasing diversity in physics. If you have questions, comments, or ideas, please e-mail cuwip@Virginia.edu. Here's to a future of equal opportunities, mutual support, and innovation in physics.

Acknowledgements: CUWiP with SPIN-UPx was organized by a multi-disciplinary group of faculty and students at UVa spanning the departments of Physics, Astronomy, Materials Science and Engineering, and the National Radio Astronomy Laboratory. CUWiP sponsors include the National Science Foundation, the Department of Energy, UVa's Department of Physics, the Society for Physics Students, Sigma Xi, Jefferson Science Associates, LLC, Old Dominion University Department of Physics, the Department of Materials Science and Engineering, the Office of Diversity and Engagement in the School of Engineering and Applied Science, UVa's Astronomy Department, the National Radio Astronomy Laboratory, UVa's Parents' Fund, and New Sky Capital (Dr. Stefania Perrucci). We thank all of our academic and industrial speakers who volunteered time to speak at SPIN UPx and CUWiP.

More information about the event, such as speakers, sponsors, and a photo gallery, can be found at http://cuwip.phys.virginia.edu.

Martine Lokken was an Astronomy-Physics major at the University of Virginia. She is now a gradaute student in Astronomy at the University of Toronto.

For more information on APS' CUWiP series, please see https://www.aps.org/programs/women/workshops/cuwip.cfm.

Spotlight on Recent Graduates – In Their Own Words

A Circuitous Route: Don't Be Afraid to Change Course if your Initial Trajectory is Askew

Julie Logan, Class of 2015

The route that I have taken to my current state as a PhD student in Nuclear Engineering at MIT has been far from direct. Although the linear route is certainly the shortest and usually the easiest path to take, there will be resistance in any circuit and it is through resistance that power is generated after all. In detailing my academic journey, I hope to encourage self-reflection in my peers and to embolden them to pursue their true passions, even if doing so requires decisive action and daunting amounts of work. Large decisions that alter the trajectory of one's path are never easy, but sometimes it is necessary to redirect if you truly want to obtain an optimal end state. I would like to lay out my academic path to encourage my peers to not let fear or a formidable workload prevent them from getting where they truly want to be.

I first discovered my passion for physics in AP physics in High School. For me, the main draw was figuring out why things progress in the world as they do or what mechanism allows a particular technology to function as it does. To me, nothing was cooler than the ability to predict how things would proceed, so quite naturally I showed up at UVa in 2011 keen to study engineering. Not knowing the particular type of engineering that I would suit, I dabbled and inquired and explored and ended up choosing Systems Engineering. Since I enjoyed understanding the interactions and mechanisms of processes, the choice was a rational one and I applied for and received the DoD SMART Fellowship in Systems Engineering, with my sponsoring facility being HQ Air Force Material Command (AFMC) (Dayton, Ohio). Although I was certainly learning how engineering systems operate, I soon grew to miss learning about the more fundamental question of why. For this, I returned to physics, taking some classes simply for fun, and resumed my quest to understand why things proceed in the world as they do. I maintained my fellowship and pursuit of Systems Engineering, but came to realize that I could feasibly turn the classes that I had taken in the physics department, out of pure, undiluted curiosity, into a double major. I relished the physics classes and found Applied Nuclear Physics to be particularly interesting, specifically the potential to harness nuclear-scale forces for the good of mankind. This pivotal decision to pursue a double major in Physics was the first reorientation of my initial path. I made the choice in pursuit of my passions following substantial self-analysis and it permitted me to tilt my career trajectory toward my current position. This self-awareness and willingness to seize available opportunities are traits that I would urge my peers to ponder.

Immediately upon graduation I went to work for HQ Air Force Material Command (AFMC) (Dayton, Ohio) due to the stipulations of my fellowship. Concurrently, I had the wonderful opportunity to attend classes at the Air Force Institute of Technology (AFIT, the Air Force's graduate school), in pursuit of a Master's Degree in Nuclear Engineering. Given my previous tremendous interest in the topic, the choice to study Nuclear Engineering was not a difficult one, but it was certainly a decisive step that constituted the final reorientation that led me to where I am today. Surmounting fear of failure or lack of acceptance was critical in finding my way in the world.

A typical day consisted of going to work at HQ AFMC, at which I did Operations Research analysis supporting Air Force material allocations and logistics, followed by attending classes in the afternoon and early evening. My physics degree from UVa set me up well to succeed at AFIT, especially the Applied Nuclear Physics course which I mentioned previously. I enjoyed my studies tremendously, with the firm conviction that in the rich field of Nuclear Engineering I had found the topic for me. I knew this to be the case when I realized that I would rather study for an exam than do most other leisure activities. My thesis work for my Master's degree was focused on developing a novel gamma source imaging system using a rotating scatter mask. Basically, the system that I simulated and demonstrated in experiment was able to point the user in the direction of a source emitting gamma radiation because the mask thickness varied in a unique manner for each relative position of the source in 4pi. I successfully defended this thesis and graduated from AFIT in 2017. In the months preceding my graduation, I pondered my next steps, as

See *Recent Graduates* on page 6.

Recent Graduates *(continued)*

I really wanted to continue to research and deepen my knowledge of Nuclear Engineering. This being the case, a PhD seemed the logical next step. My thesis advisor at AFIT, Lt Col Buckley O'Day, encouraged my aspirations. As a supporting mentor and paragon of hard work and motivation, he emphasized the importance of never "self-selecting" out, but rather aiming high and seizing any available opportunity. With his support, I applied to and was accepted into MIT's Department of Nuclear Engineering. I also applied for and received the DoD SMART fellowship again, but this time to pursue my PhD in Nuclear Engineering, with my new sponsoring facility being Air Force Research Lab Space Vehicles Directorate (AFRL/RV) in Albuquerque, New Mexico. Upon writing this, I have just finished my first year at MIT, having taken my last written qualifying exam this week. I am in the airport now on my way to New Mexico to begin the summer at AFRL/RV in Albuquerque. I feel very excited to begin this work, through which I can apply my gained knowledge in and passion for Nuclear Engineering to assist the Air Force in assuring that their sensitive electronics will continue to operate in the space radiation environment. In summary, I would like to emphasize to my peers that it is never too late to pursue your passion and not to let fear or hard work dissuade you from finding your vocation.

My Path to Academia

Jennifer Cano, Class of 2009

When I arrived on Grounds in Fall 2005, I signed up for math, physics, and chemistry classes. I wanted to keep my options open. But in the spring, when I introduced myself to Olivier Pfister (as a requirement of his Electricity & Magnetism class) he asked, "Why don't you major in physics?" I liked the challenge of the coursework and the classmates I had met, so I declared my physics major that day.

The following summer, I traveled to the University of Rochester for an REU program. My project was to post-process particle accelerator data, putting to use the programming skills I had learned in Bob Hirosky's Fundamentals of Computational Physics course. The REU program was a great opportunity and gave me a taste of research. When I returned to Grounds, I was eager to find another research opportunity. I started in Despina Louca's lab, but I wanted something more mathematical. In the spring, I saw an ad for a biophysics research position with Tony Spano to analyze photoluminescence data. Tony promised that if I taught him the math to write the code, he would teach me biology. This sounded like a great deal, and I learned to duplicate pieces of DNA.

Although I enjoyed the lab, I wanted to try theoretical physics. At one of the SPS meetings, Paul Fendley described his research on topological quantum computing. I was intrigued, and asked if I could work on a project with him. He handed me some papers to read, assuming I would not come back. But I did, and my persistence paid off, as we started a project on exactly solvable dimer models the following summer. The project combined both computational and analytical physics, and I loved it.

In the spring, I received a Harrison Undergraduate Research Grant to travel with Paul to Oxford for the summer. Unlike my REU experience, my time in the UK was sometimes lonely: I had some culture shock, both because I had never lived in a European country and because I hardly saw any female physicists at Oxford. But I enjoyed the research, and decided to apply to graduate school.

In 2009, I started my PhD at UC Santa Barbara. Grad school is full of ups and downs, on a much longer time scale than I was used to. My first project took many years of trial and error. At risk of burning out, I realized I had to define myself outside of physics, so I joined the triathlon team. When I am swimming, biking, or running, I am working too hard to think about the frustrations of research. It is the perfect outlet for me and I continue to make it a priority to train and race.

I eventually found my stride in research. I also became accustomed to the slow time scales and realized that the frustrations make the victories sweeter. I decided to keep working towards a career in academia.

In Fall 2015 I started as a postdoctoral fellow at the Princeton Center for Theoretical Science. I was intimidated by my colleagues, but also excited for the new challenge. My time at Princeton was very different than in California: first, I started working in the fast-paced field of topological semimetals, which created pressure

See *Recent Graduates* on page 7.

Recent Graduates *(continued)*

to produce results quickly. Second, I transitioned to more materials-oriented research; I really enjoyed this aspect because I could communicate with more people, including experimentalists. In the future, I hope to balance my research projects between abstract and applied theory.

This fall, I am starting as an Assistant Professor at Stony Brook University, with a partial appointment at the new Flatiron Center for Computational Quantum Physics in Manhattan. As with each new stage of my research career, I am terrified and excited by the new challenges. But I know that these challenges are what keep me interested. Research can be stressful, but never stale. I enjoy the freedom of choosing what to think about every day and collaborations with (and travel to) friends around the world.

My path looks linear, but at any step, things could have gone differently: I could as easily be working at a biophysics start-up or as a data analyst as pursuing a research career in theoretical physics. But for each possible outcome, the research and classroom experiences I had as a physics major at UVA would have prepared me for success.

We welcome contributions to our "recent graduate" stories. Please send your story to Xiaochao Zheng, xz5y@virginia.edu.

Research Highlights

Quantum Computing Over The Rainbow

Olivier Pfister has been doing fundamental research in quantum optics, which leverages both the undulatory (electromagnetic-wave) and corpuscular (photon) natures of quantum light in order to lower the fundamental noise of precision measurements and, in particular, interferometric ones. In interferometry, two waves add in or out of phase depending on their phase difference, which allows the latter to be measured extremely precisely. The fundamental noise of this measurement is then conditioned by the photon statistics, which can be carefully engineered, by generating "squeezed" light with reduced quantum noise, to increase the sensitivity of interferometric measurements by lowering their noise floor.[1] This was first demonstrated with squeezed vacuum fields in 1987 at U. Texas and at Bell Labs. In 2004, Pfister's group demonstrated this for heterodyne polarimetry with bright beams.

Since 2004, the Pfister group has expanded its scope after discovering that quantum optics is a possible platform for quantum computing. Quantum computers are still hypothetical machines that hold revolutionary promises for scientific discovery, following an initial bold proposal by Richard Feynman in 1982. Quantum bits, a.k.a. qubits, differ from the bits of a classical computer in that they are quantum states and can therefore exist in superpositions of (quantum) logic states "0" and "1."

1 A spectacular example of interferometry at its ultimate sensitivity is the Laser Interferometer Gravitational-wave Observatory (LIGO), which has provided the first-ever direct observation of the distortions of four-dimensional spacetime caused by dramatic gravitational events such as the collision of two black holes. The next upgrade to LIGO will be the addition of squeezed quantum light in order to lower its noise floor and decuple sensitivity.

What is this good for? Good question. It would appear that finding quantum algorithms, somewhat ironically, is a hard mathematical problem in and of itself. The irony is due to the fact that some quantum algorithms, such as Shor's factoring algorithm and Feynman's quantum simulation, are incredibly powerful and promise an exponential speedup over classical computers.

No experimental paradigm yet exists for making a practical (fault tolerant, large-scale) quantum computer and several platforms are currently competing for performance, such as optically trapped ions or atoms, or superconducting circuits. The challenge is daunting and twofold: on one hand, one must be able to exert exquisite levels of control over qubits, which are quantum systems (e.g. single atoms) and therefore prone to random state changes, a phenomenon known as decoherence. On the other hand, one also needs scalable computer architectures with large numbers of qubits all entangled together in a display of such quantum correlations (first discovered by Einstein, Podolsky, and Rosen) as to be worthy of Schrödinger's famous nightmarish picture of a cat both alive and dead.

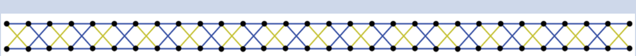


Figure 1. Graphical representation of a 60-qumode (vertices) quantum state, entangled as per the graph edges (blue and yellow). Each qumode act as a qubit and the quantum correlations from the preëstablished entanglement can be used to implement universal quantum computing.

See *Research Highlights* on page 8.

Research Highlights *(continued)*

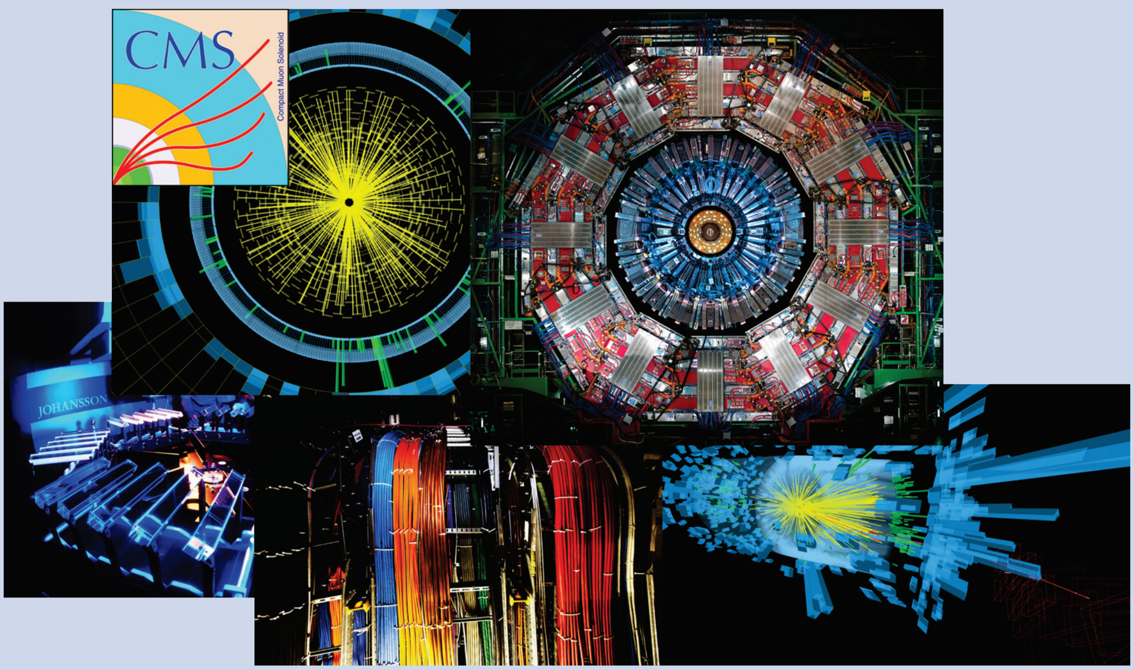
Pfister's original and promising approach to building a practical quantum computer uses quantum optical fields of light that differ by their color, as defined by the emitting frequencies of an exotic laser called an optical parametric oscillator (OPO). In that sense, each qubit is realized by an oscillation mode, a.k.a. qumode, of the OPO. In their laboratory in the basement of the Physics building at UVa, the graduate students of Pfister's group have built prototype quantum computing processors of world record size with 60 qumodes confirmed (figure on page 7) and several thousands expected.

Pfister and his group are now seeking to build on this experimental success and leverage this record scalability to perform quantum simulation of difficult, intractable problems in condensed matter and high-energy physics, in collaboration with the theory groups of Israel Klich and Diana Vaman in the Physics Department, as well as other experimental groups in Oak Ridge National Laboratory, São Paulo, and Paris.

It's all about the data

The Large Hadron Collider (LHC) at the CERN laboratory in Geneva Switzerland is the world's largest machine used for physics research and the most powerful particle collider ever constructed. Measuring 27 kilometers (16.8 miles) around, the LHC is designed to accelerate protons up to 99.9999991% of the speed of light and also to accelerate heavy nuclei to extremely high energies. After traveling about half a billion miles during acceleration (that's quite a running start!), the particle beams are focused to pinpoint accuracy and collided to produce extreme conditions for studying the behavior of matter not seen since the beginning of the universe.

Professors Cox, Hirosky, and Neu work with the CMS Collaboration to build and operate the massive-particle detectors required to study these high energy collisions. One of the challenges of doing research at these machines is dealing with an astounding flow of data. Every second hundreds of millions of collisions occur and our detector systems must efficiently scan the results, identifying the small fraction of interesting collision events for further analysis. We use these data to explore the fundamental properties of matter, how exotic particles are produced and interact, and to search for entirely new forms of matter and forces of nature.



Clockwise from upper left: Radial projection of a detected proton-proton collision event in the CMS detector. A cross section view of the CMS detector. Another collision shown in a 3D view. A small section of the typical cable plan accompanying large collider detectors. Lead and Tungsten crystals used for particle detection in the CMS electromagnetic calorimeter. (credit: CERN) For more information about the CMS Experiment, see https://cms.cern/.

See *Research Highlights* on page 9.

Research Highlights *(continued)*

The UVa group has contributed to the electromagnetic and hadronic calorimeter detectors at CMS for over a decade. These are used to precisely measure the energy of particles produced in collisions at the LHC and, for example, played a central role in the long-sought discovery of the Higgs boson which led to the awarding of the Nobel Prize in 2013. But we're not finished yet. We continue to search for new clues to understand the confusing reality of particle masses, the sizes of "m" in $E=mc^2$, the preference of matter over anti-matter in the universe, the questions of dark matter and dark energy.

To move forward we need to study or search for new types of extrodinarily rare processes. These processes occur at rates of less that one in a hundred-million-million collisions. (Think of needles in a haystack hidden in a Mount Everest of haystacks!) Studying this very rare phenomenon requires the collection and analysis of enourmous amounts of data. To keep our detectors up to the challenge of examining these huge volumes of data, major upgrade projects are underway to operate with collisions of even more intense particle beams after upgrades to the LHC machine in 2025 and beyond. Professor Hirosky is part of the management group for the US contributions to this upgrade and his team at UVa will be reponsible for an enhanced electronics readout system for the CMS electromagnetic calorimeter, capable of receiving and processing the huge flow of data, which is about equal to 3 million simultaneous Netflix streams, coming from thousands of fiber links to the detector. Our electronics will process this entire data stream as part of a real time analysis system. These enhanced capabilities to receive and process data from our detectors will allow us to push ever further into exploring the unknown secrets of the natural world and provide the next generation of students and scientists at UVa with exceptional opportunities to build new state of the art detectors and lead the work towards new discoveries about the physics of matter and the universe.

Honors and Awards

Undergraduate Students

Stephen Stetzler was awarded a DOE Computational Science Graduate Fellowship.

Brian C. Seymour and **Stephen Stetzler** each received a scholarship from the Astronaut Scholarship Foundation.

Chris Li won a Goldwater Scholarship.

Arvind Gupta, **Kevin Lee**, and **Timothy McMullen** have been elected to Phi Beta Kappa.

UVa's SPS Chapter was named a 2016-17 SPS outstanding chapter.

Jiwon "Jesse" Han won a 2017 Ig Nobel Prize.

Lingnan Shen received the Lawrence Harrison Kilmon and May Lewis Kilmon Scholarship.

Graduate Students

Andrew Sutton received a DOE SCGSR Fellowship.

Tianran Chen won the 2018 Allen Talbott Gwathmey Memorial Award. **Tianran also** received the Symposium ES1 Best Poster Presentation Award at the 2017 MRS Spring Meeting.

Faculty

Despina Louca has been appointed the Maxine S. & Jesse W. Beams Professor of Physics.

Gordon Cates has been appointed the Jesse W. Beams Professor of Physics.

Alumni News

Matthew Caplan (BS 2013) received the 2018 APS Dissertation Award in Nuclear Physics.

M. Lisa Manning (BS 2002) received the 2018 APS Maria Goeppert Mayer Award.

Tianran Chen won a NIST postdoctoral fellowship.

Thank You!

We greatly appreciate your continued support of the Deaver Scholarship Fund, general pledges and new initiatives. For additional information, please contact:

Casey Davis, Assistant Director of Development
E-mail: casey.davis@virginia.edu
Tel: 434-924-6141
Arts & Sciences Development Office
P.O. Box 400801
Charlottesville, VA 22904-4801

Retirement News

Five professors retired from the Physic Department over the past year. We thank them for their many years of service to the department and wish them well in retirement.

Donald G. Crabb

PhD, Southampton University, Southampton, UK
Research Professor of Physics
College of Arts & Sciences 1990 – 2018

Donald Crabb received his doctoral degree in (what was then) High Energy Particle Physics from Southampton University in 1967 and came to the University of Virginia in 1990, after various positions at the University of Southampton, University of Michigan, St. Louis University, and Oxford University (UK). During a career of experiments in particle physics at the Rutherford Laboratory, Argonne National Lab, CERN, Brookhaven National Lab, SLAC and Jefferson Lab, he built polarized targets for studying spin effects in particle physics.

His time at the University of Virginia was devoted to building up the Polarized Target Lab in the Physics Department while continuing to participate in experiments at various accelerators in the US and Europe. These included highly-cited experiments at SLAC (E143, E155, E155'), for which he built the target, and at CERN (SMC) which showed that the quark contribution to the spin of the proton was only about 25% of the value, the "spin crisis".

Crabb was named an American Physical Society Fellow in 2009 for his contributions to the use of high field polarized targets and development of high polarization and radiation resistant polarized target materials and his role in using them in seminal particle physics experiments and advancing the knowledge of the behavior in high intensity beams.

Michael Fowler

PhD, St. John's College, Cambridge, UK
Maxine S. and Jesse W. Beams Professor of Physics
College of Arts & Sciences 1968 – 2018

A world-class theoretical physicist acclaimed for solving challenging mathematical physics problems, Michael Fowler retires as the Maxine S. and Jesse W. Beams Professor of Physics. He received his doctoral degree in theoretical physics 1962 and arrived at UVa in 1968 from the University of Toronto. For his seminal work on elucidating the physics of one-dimensional systems, he was elected a Fellow of the American Physical Society.

Retiring faculty were honored with a reception at the Colonnade Club in May. Left to right: Hank Thacker, Michael Fowler, Don Crabb, Tom Gallagher, and Steve Thornton.

A devoted teacher, Fowler was recognized with the George Pegram Award of the Southeastern Section of the American Physical Society for his achievements in teaching physics at all levels, outreach efforts, and global influence on physics teaching through his websites. His teaching materials on his course websites are now widely used across the world in universities, colleges, and high schools. During his UVa career, Fowler served two separate terms as chair of the department and served on the College of Arts & Sciences Tenure and Promotion Committee, among many other University committees.

Michael often accompanies his wife Tyler Jo Smith, an associate professor of Mediterranean art and archaeology at UVa, to conferences, archaeological surveys, and excavations in Turkey, Greece, and Italy.

Thomas F. Gallagher

PhD, Harvard University
Jesse W. Beams Professor of Physics
College of Arts & Sciences 1984 – 2018

Thomas Gallagher received his doctoral degree in experimental atomic physics from Harvard University in 1971 and came to the University of Virginia from Stanford Research Institute in Menlo Park, California in 1984. He was the Jesse W. Beams Professor of Physics and has been celebrated for his seminal elucidation of the properties of highly excited "Rydberg" atoms, which provide him a platform to explore emergent properties at the interface of classical and quantum physics. As the members of a recent department review panel remarked, "Tom Gallagher literally wrote the book on Rydberg atoms."

See *Retirement News* on page 11.

Retirement News *(continued)*

Gallagher's honors and recognitions include election as an American Physical Society Fellow and an Optical Society of America Fellow, the 1996 Davisson-Germer Prize from the American Physical Society (APS), the 1997 Virginia's Outstanding Scientist Award, and the 2011 University of Virginia's Distinguished Scientist Award. His many leadership roles include chairing the APS Division of Atomic, Molecular, and Optical Physics. A former department chair, Gallagher also served on the College of Arts & Sciences Tenure and Promotion Committee, among many other University committees.

As a Harvard graduate student, Tom would repair his MG sports car with tools passed through laboratory windows. He still has that MG, along with other old British cars he still fixes himself. He is never so happy as when he's rebuilding a worn-out suspension, figuring out how to keep a wheel from coming loose, or crafting beautiful furniture for family and friends out of hardwood collected from fallen trees.

Harry B. Thacker

PhD, University of California, Los Angeles
Professor of Physics
College of Arts & Sciences 1989 – 2018

Hank Thacker came to the University of Virginia from the Fermi National Accelerator Laboratory as a professor of physics in 1989. Thacker's work in theoretical physics resides at the intersection of theoretical particle physics and mathematical physics. His seminal contributions to the study of quantum field theory concern the area of strong interaction between quarks and gluons, the fundamental particles that make up the protons and neutrons, as well as studies of properties of the Higgs particle. The work on the Higgs particle contributed to the design and motivation for the Large Hadron Collider at CERN (European Council for Nuclear Research). Thacker's work also includes extensive application of computational methods in the area of lattice field theory.

Thacker was elected a fellow of the American Physical Society in recognition of his contributions to fundamental physics. At UVa, he spearheaded a computational physics course for undergraduates and graduate students within and outside the department of physics. His course laid the ground work for the department to establish computational science as one of the concentration areas.

Hank and his wife have three sons and one granddaughter. Hank and Eileen have been married 42 years, and they are both bluegrass musicians; he plays the banjo; she plays the mandolin. They play music with many members of the old time music community throughout Virginia, West Virginia, and North Carolina.

Stephen T. Thornton

PhD, University of Tennessee, Knoxville
Professor of Physics
College of Arts & Sciences 1968 – 2017

Stephen Thornton received his doctoral degree from the University of Tennessee in 1967 and joined the University of Virginia as an assistant professor the following year. He performed his nuclear physics experiments at Oak Ridge National Laboratory, Heidelberg, SLAC, and Brookhaven National Laboratory and has been awarded the U.S. Senior Fulbright-Hays Fellowship and Max-Planck Fellowship for his research. He has more than 125 research publications and has written three physics textbooks. Thornton also directed the research of 20 graduate students.

Like many educators, Thornton is concerned about the shortage of qualified physics teachers in the United States: with this in mind, he co-established the Master of Arts in Physics Education (MAPE) program. He served as director of the MAPE program and taught half the courses until his recent retirement. The program has graduated more than 150 high school physics teachers.

Thornton was elected a fellow of the American Physical Society for his seminal contributions to physics education, especially for the preparation of K-12 teachers. He was also the recipient of the 2013 George B. Pegram Award of the Southeastern Section of the APS, an award which recognizes excellence in the teaching of physics. He has long blended lectures and demonstrations in his larger courses, and this occasionally meant putting on a safety helmet and mounting a tricycle to which he strapped a fire-extinguisher-sized bottle of carbon dioxide. The sight of Thornton rocketing across the lecture hall delighted his students, if not the University's fire marshall.

Stephen inaugurated the annual National Physics Day Show at UVa and has presented physics demonstration shows to more than 35,000 people throughout Virginia.

University of Virginia
Department of Physics
382 McCormick Road
P.O.Box 400714
Charlottesville, VA 22904-4714

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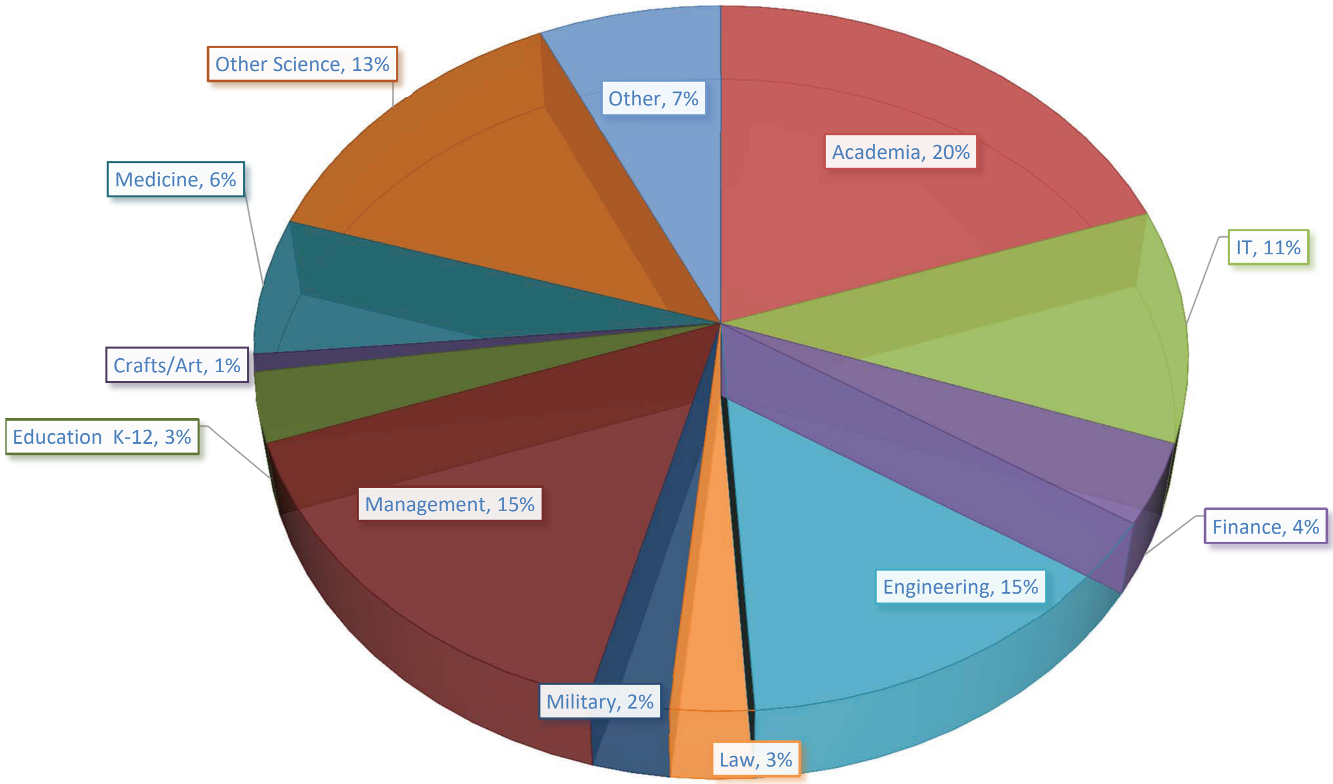
% UVa Physics Graduates (1965-2017) in Various Job Sectors*

* with available data from 750 out of 1,830 graduates



Graph made by Rachel Walet (rbw5pf@virginia.edu), class of 2021, Government (major) and Spanish (minor).

Please send address changes, comments, and suggestions about the newsletter to physicsnewsletter@virginia.edu.