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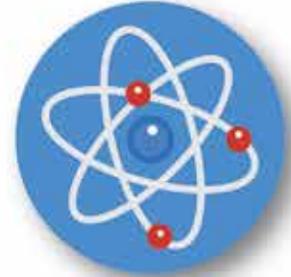
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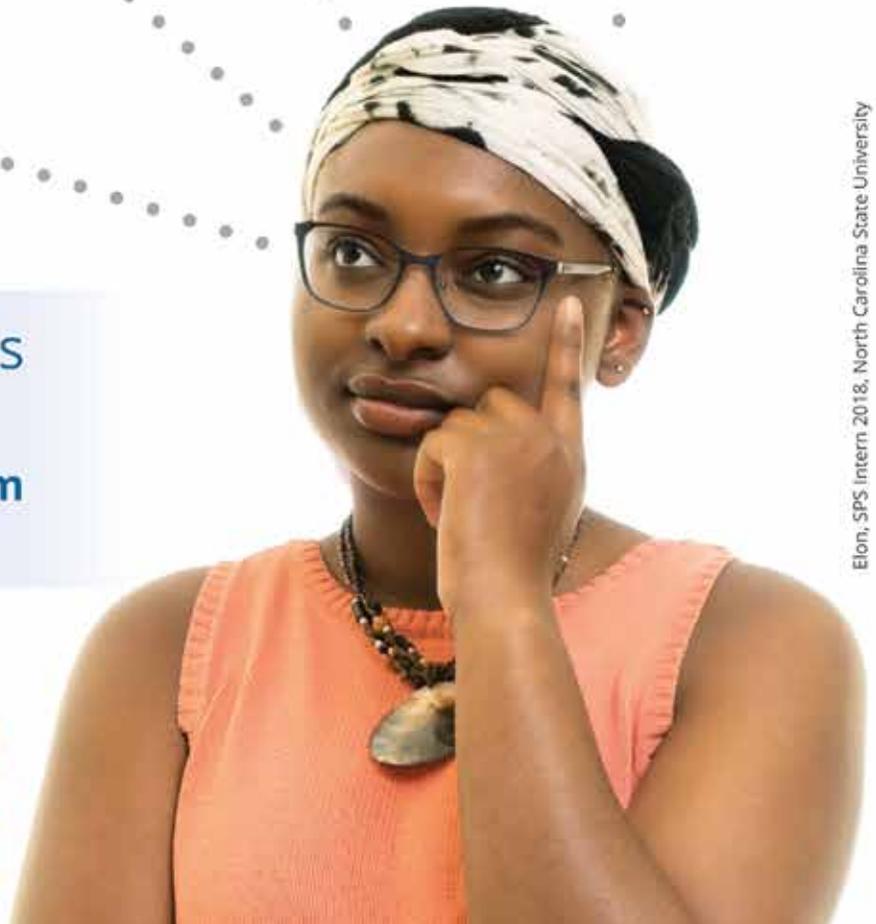


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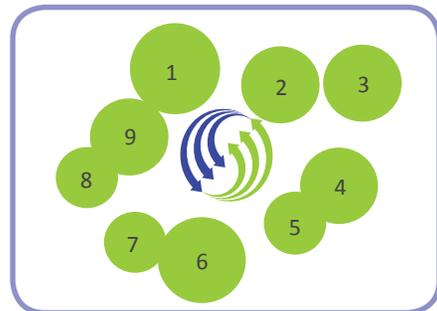
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CONTENTS



ON THE COVER

A sampling of things you can learn more about at PhysCon 2019! Photos courtesy of AIP unless otherwise noted.

1. The James Webb Space Telescope, the current focus of PhysCon keynote and Nobel laureate John Mather. Photo courtesy of NASA.
2. The iconic SPS spherical cow.
3. We are all made of starstuff - Winner of the Unifying Fields Art Prize at PhysCon 2016.
- 4 & 8. PhysCon 2016 attendees were all smiles as they toured scientific hot spots and shared their research and outreach efforts with new friends.
5. Asterism - Winner of Best in Show and Peoples' Choice prizes at PhysCon 2016.
6. Carla Ramsdell's energy-efficient pizza at PhysCon 2019. Photo by Kendra Redmond.
7. PhysCon 2019 honorary chair Jocelyn Bell Burnell.
9. A programmable calculator used in the NASA Shuttle Mission Simulator from the Ladd Observatory history of science collection. Photo by Michael L. Umbricht / Ladd Observatory.

5 Your Dollars At Work

- 5 Love in the Lab
- 6 Fall 2018 Chapter Awards

10 Features

- 10 Prepare to Make Waves
- 11 Such Great Heights: Sandeep Giri
- 12 Energizing Change: Ellen Williams
- 13 Dr. First: Jami Valentine Miller
- 14 A Physics Tour of Providence
- 16 Five Books about Physics That Stood Out in 2018

22 Elegant Connections in Physics

- 22 Reflections on the 2016 Congress Theme

26 Spotlight on Hidden Physicists

- 26 Michael Street, the Coder
- 27 Alex Kubicek, the CEO

28 Unifying Fields

- 28 Making a Greener Pizza
- 30 Reenergizing Sigma Pi Sigma: A Call to Action

Departments

- 4 Letter from the CEO
- 8 Chapter Profiles
- 18 Member Notes
- 32 2018 Contributors to Sigma Pi Sigma

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LETTER FROM THE CEO

Why AIP Supports PhysCon

by Michael Moloney, CEO, American Institute of Physics



When you're an undergraduate student, there are few opportunities to travel to present your work. There are even fewer opportunities to attend a professional conference and network with like-minded people.

That's why I am so excited about the 2019 Physics Congress, also known as PhysCon, which has been hosted since 1928 by you and your fellow Sigma Pi Sigma members. PhysCon is the only event of its kind in the United States that is tailored specifically to college students in the physical sciences. PhysCon 2019 will bring together more than 1,500 students of physics and astronomy, along with mentors, alumni, and renowned scientists, for a life-changing experience Nov. 14–16 in Providence, Rhode Island.

Attendees will hear from luminaries in physics and astronomy, go on tours of local research labs and facilities, engage in workshops, and have opportunities to present their research and outreach efforts. The entire event is planned with students in mind, and I see it as an incredibly empowering experience for them.

This will be my first PhysCon as CEO of the American Institute of Physics, and I could not be more enthusiastic about what we have planned. The theme for PhysCon 2019 is *Making Waves and Breaking Boundaries*, which is extremely apt for what we will offer in Providence. It is my goal that students who attend PhysCon will go back to their respective universities inspired to continue their studies and excited about the career paths open to them. I truly want them to make waves and continue breaking scientific boundaries.

If you've attended PhysCon in the past, you know how rewarding and inspiring the experience can be for students. I'm hoping that together we can make 2019 the best PhysCon yet.

But despite how excited we all are for PhysCon 2019, we know its success depends on the support of people like you. If you would like to support PhysCon 2019, consider donating your time or money. AIP has established the Congress Student Travel Fund, geared specifically toward supporting student travel to PhysCon. You can find more information at donate.aip.org.

We also will be looking for volunteers in the New England region to join us for our Lunch with the Scientists event on Friday, Nov. 15. If you would like to learn more about volunteering, please reach out to sigmapisigma@aip.org.

And if you are an employer or university representative who is looking for interns, employees, or graduate students, consider exhibiting at PhysCon. More information about exhibiting opportunities can be found on the PhysCon website, or you can email Vanessa Bridges at vbbridges@aip.org.

I cannot wait to see you and all of the students in Providence, Rhode Island, for PhysCon 2019. ●

Love in the Lab

by Mariann Salisbury, Director of Development, American Institute of Physics



Jonathan and Mahela Morrow-Jones showing their shared love for Dr. Who. Photo courtesy of Mahela Morrow-Jones.

For the future of physics, Jonathan and Mahela Morrow-Jones support student travel to PhysCon 2019.

Jonathan and Mahela Morrow-Jones met in the physics lab at Virginia Commonwealth University (VCU) in the early 1980s. Back then, VCU did not have a physics graduate program, so undergrads were sometimes hired as teaching and research assistants. The physics professors kindly kept the lab open all night so students could pull amazingly chaotic all-nighters doing homework and studying for tests. The winters were cold, but the labs would become cozy retreats as someone would bring a couple of pizzas and bags of

taco chips, and before you realized it, the chalkboards were filled, it was five in the morning, students were better prepared for their tests, and it was time for everyone to wander home.

Mahela remembers that while all the students loved physics, money to expand their professional development was tight. Once an opportunity developed to travel with their professor 60 miles west to the physics department at the University of Virginia in Charlottesville to see what the students were up to there. During these kinds of outings one of the professors would drive and pay for gas and lunches.

Jonathan and Mahela graduated and married in 1983 and moved to California, where Jonathan earned his PhD in string theory from the University of California, Santa Barbara. Jonathan has enjoyed being a physics researcher all this time, and Mahela spent decades as a technical writer. She now tutors physics and math to at-risk high school students.

Given their own experiences, the couple understands the excitement and value of getting together with other physics students and being a part of a larger scientific community. They also understand the expense, which is why they hope others will join them in helping the next generation of physicists experience the dynamic community of PhysCon 2019. ●

The American Institute of Physics is a federation of scientific societies in the physical sciences, representing scientists, engineers, educators, and students. AIP offers authoritative information, services, and expertise in physics education and student programs, science communication, government relations, career services, statistical research in physics employment and education, industrial outreach, and history of the physical sciences. AIP publishes *Physics Today*, the most closely followed magazine of the physical sciences community, and is also home to the Society of Physics Students and the Niels Bohr Library & Archives. AIP owns AIP Publishing LLC, a scholarly publisher in the physical and related sciences. www.aip.org

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- American Association of Physics Teachers
- American Astronomical Society
- American Crystallographic Association
- American Meteorological Society
- American Physical Society
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- The Optical Society
- The Society of Rheology

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- Sigma Pi Sigma
- Society of Physics Students
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Fall 2018 Chapter Awards

Congratulations to the following winners of the Fall 2018 Chapter Awards. These awards are made possible in part by generous contributions from Sigma Pi Sigma alumni. For examples of past award-winning projects, visit <http://www.spsnational.org/awards/chapter-awards>.

Future Faces of Physics

Future Faces of Physics Awards are made to SPS chapters to support projects designed to promote physics across cultures. The goal of the Future Faces of Physics Award is to promote the recruitment and retention of people from groups historically underrepresented in physics.

Adelphi University

Labs for Kids

Julianna Yee (Leader)

Matthew Wright (Advisor)

California State University – San Marcos

CSUSM's Aim for Diversity in Physics

Carina Maciel (Leader)

Justin Perron (Advisor)

Colorado School of Mines

Future Faces of Physics with CSM SPS

Dylan Honors (Leader)

Chuck Stone (Advisor)

Ithaca College

Minority Groups in STEM

Stavrini Tsangari (Leader)

Michael "Bodhi" Rogers (Advisor)

Juniata College

Diversity and Inclusion in Physics at Juniata

Camden Kasik (Leader)

Jim Borgardt (Advisor)

Rhodes College

Uplifting Students with Hovercrafts:

A Smooth Introduction to Physics

David Raymond (Leader)

Brent Hoffmeister (Advisor)

The George Washington University

"I Can Science"

Jason Starita (Leader)

Gary White (Advisor)

University of the Sciences

Shining Light on the World of Optics

Despina Nakos (Leader)

Roberto Ramos (Advisor)

William Jewell College

After-School Activity Series

Megan Anderson (Leader)

Blane Baker (Advisor)

Marsh W. White

Marsh W. White Awards are made to SPS chapters to support projects designed to promote interest in physics among students and the general public. The Marsh W. White Award dates back to 1975 and is named in honor of Dr. Marsh W. White for his long years of service to Sigma Pi Sigma and the community.

Augustana College

Spring into Physics!

Emmalee Pentek (Leader)

Cecelia Vogel (Advisor)

Cleveland State University

Fun with Fluids Outreach

James Ellis (Leader)

Kiril Stretletzky (Advisor)

Drew University

Local High School Physics Engagement

Matthew Gronert (Leader)

Bjorg Larson (Advisor)

Henderson State University

Science Olympics

Rebecca Voss (Leader)

Shannon Clardy (Advisor)

Juniata College

Juniata's Physics Outreach: Demo Upgrades

Evan Ulrich (Leader)

Jim Borgardt (Advisor)

Rhodes College

SPS Super Sound Science Show

David Raymond (Leader)

Brent Hoffmeister (Advisor)

Southwestern Oklahoma State University

Dohtometry: Helping Western Oklahoma See the Stars

Emily Trail (Leader)

Wayne Trail (Advisor)

Towson University

Science Friday
Bailey Conrad (Leader)
Jeff Simpson (Advisor)

University of Dayton

TechFest 2019: Electro-Physics Exhibit
Dalles DeBruin (Leader)
Jay Mathews (Advisor)

University of Florida

Crash Course in Fundamental Force
Foster Sabatino (Leader)
James Hamlin (Advisor)

University of Maryland

Quantum Kids: You Got This!
Tyler McDonnell (Leader)
Donna Hammer (Advisor)

University of Southern Mississippi

Physics for All
Swapnil Bhatta (Leader)
Michael Vera (Advisor)

University of Texas at Dallas

Physics Escape Room
Andrew Marder (Leader)
Jason Slinker (Advisor)

University of the Sciences

Throwing You for a Loop
Gopal Goberdhan (Leader)
Roberto Ramos (Advisor)

SPS Chapter Research

The SPS Chapter Research Award program provides calendar-year grants to support local chapter activities that are deemed imaginative and likely to contribute to the strengthening of the SPS program.

Coe College

Ionic Conductivity of the Lithium Clustering Effect
Anne Ruckman (Leader)
Caio Bragatto (Advisor)

Suffolk University

Neutron Radiation
Molly McDonough (Leader)
Walter Johnson (Advisor)

Universidad Autonoma de Ciudad Juarez

Foucault Pendulum
Julio Lopez Ibarra (Leader)
Sergio Flores (Advisor)

University of Central Arkansas

Small Parallel Supercomputer at UCA
John Singel (Leader)
William Slaton (Advisor)

University of Kentucky

Data Analysis and Accuracy: Small Supercomputer versus a Dell Dinosaur
Dany Waller (Leader)
Max Brown (Advisor)

University of Tennessee, Knoxville

HARAMOC
Peter Tarle (Leader)
Maxim Lavrentovich (Advisor)

Sigma Pi Sigma Chapter Project

The Sigma Pi Sigma Chapter Project Award provides funding of up to \$500 for chapter inductions and events.

Abilene Christian University

Sigma Pi Sigma Induction
Roy Salinas (Leader)
Larry Isenhowe (Advisor)

California State University - Fresno

Dining with the Director: An Induction Ceremony with Alumni
Summer Al-Hamdani (Leader)
Douglas Singleton (Advisor)

Lamar University

2019 Sigma Pi Sigma Induction and Dinner
Alek Hutson (Leader)
Cristian Bahrim (Advisor)

Missouri Southern State University

An Emphasis on Physicists
Toby Pederson (Leader)
Jency Sundararajan (Advisor)

St. John's University

Brooklyn Bridge
Russell Lochrie (Leader)
Charles Fortmann (Advisor)

United States Air Force Academy

Building Bridges: Connecting Colorado Springs Students through SPS and Sigma Pi Sigma
Lucy Zimmerman (Leader)
Alina Gearba-Sell (Advisor)

University of Central Florida

The Central Florida Sigma Pi Sigma Induction Ceremony
Kevin Fernando (Leader)
Costas Efthimiou (Advisor)

2017–18 SPS Outstanding Chapter Advisor

The SPS Outstanding Chapter Advisor Award is the most prestigious recognition given each year by SPS. The following SPS advisors were nominated by their students, colleagues, and departments in recognition of their dedication to furthering the mission of SPS. The winner receives a total of \$5,000 for his or herself, their chapter, and their department. The winner was officially recognized at the Winter 2019 AAPT Meeting in Houston, Texas. The runner-up's chapter receives a \$100 gift card for a pizza party and other chapter activities. Learn more at <https://www.spsnational.org/awards/outstanding-chapter-advisor>.

Winner

Roberto C. Ramos,
University of the Sciences

Runner-Up

Alina Gearba-Sell,
United States Air Force Academy

Nominees

Tirthabir Biswas, Loyola University New Orleans

Martin DeWitt, High Point University

Robert Craig Group,
University of Virginia

Donna Hammer, University of Maryland – College Park

Jose L. Lopez, Seton Hall University

David Peak, Utah State University

Justin K. Perron, California State University – San Marcos

The MIT SPS/ΣΠΣ Chapter: Bringing People Together

by Kendra Redmond, Contributing Editor

Food, physics, and fellowship—that’s what fuels the Massachusetts Institute of Technology’s SPS and ΣΠΣ chapters. The two chapters go hand in hand; students are inducted into the honor society as seniors, so most of the activities fall under the SPS umbrella.

Weekly SPS study breaks offer physics students a chance to blow off some steam and fill up before attacking the next problem set. The breaks take place at different times each week, in an effort to facilitate camaraderie among one of the largest physics departments in the country. Most breaks draw 40–50 students into the physics common room.

As a way of breaking down barriers between faculty and students, about once a month a faculty member and ten physics students (chosen by lottery from those interested) head out to a local restaurant for dinner. “The idea is to create an opportunity for undergraduates to ask professors about career paths, their research, personal experiences, and advice in an informal setting,” explains SPS chapter president Megan Yamoah. The chapter organizes similar lunches with the physics department colloquium speaker every other week. The small nature of these gatherings gives attendees the opportunity to connect with peers and experts who share similar interests.

In November, the SPS students hosted the first ever Greater Boston

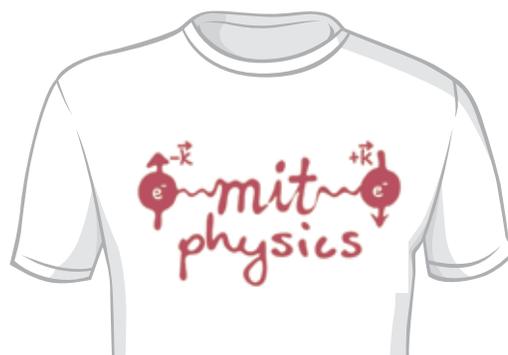


Undergraduate Physics Conference, an expanded version of a traditional MIT-Harvard undergraduate physics conference. The conference brought together students from several area institutions for research presentations, keynote talks, and a lunchtime social. The informal conversations were one of the highlights and inspired discussions about future joint events, says Yamoah. For example, the MIT and Wellesley College SPS chapters are discussing joint outreach workshops for local K-12 students.

The MIT chapter is no stranger to outreach events, but Yamoah hopes to expand their reach. “A lot of our events access a certain demographic—maybe kids whose parents are academics or who are otherwise involved in that community. I’m especially interested in reaching out to kids who don’t have that background,” she says.

Speaking of joint events, next fall SPS and ΣΠΣ members from around the country will have a chance to visit with members of the MIT chapter in their native environments—during a PhysCon tour of MIT and its labs. The chapter is already preparing for this unique opportunity and looking forward to engaging with so many physics students.

From departmental events to national engagement, what kind of food fuels all of this activity? “Before my time, I think a lot of events had Thai food,” explains Yamoah. “I’ve tried to spice it up a bit (so to speak) with other options. Generally, we do international options like Mediterranean, Indian, and Vietnamese,” she says. It’s just one more way—albeit a delicious way—that the chapter is working to bring people together. ●

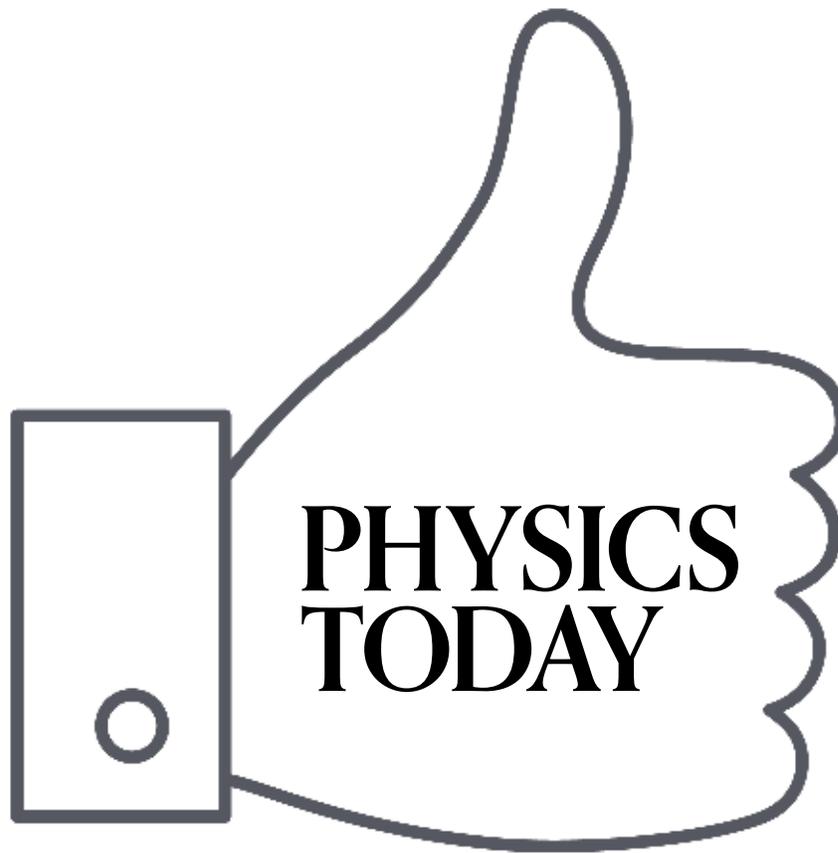


LEFT: MIT physics students enjoy an SPS-sponsored study break. Photo by Emma Dunn, MIT.

ABOVE: The winning design of the 2017 MIT SPS T-shirt contest. Image by Alfred Zona.

NEW *Alumni Engagement Program*

A founding pillar of Sigma Pi Sigma is community fellowship: on campus, off campus, and among students and alumni. A fantastic way to bring together students and alumni is to invite Sigma Pi Sigma members to participate in chapter induction ceremonies and/or department talks. In 2018, SPS National launched a new way for chapters to connect with Sigma Pi Sigma members—the Alumni Engagement Program. Through this program, alumni can volunteer as guest speakers, informational interviewees, job shadow hosts, or Adopt-a-Physicist volunteers. Virtual and in-person opportunities will be available! <http://www.spsnational.org/programs/alumni-engagement>.



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Prepare to **Make Waves**

by Brittney Hauke, PhysCon 2019 Planning Committee Member & Graduate Student, Arizona State University

We are less than a year out from the 2019 Physics Congress (PhysCon), and there is a lot to look forward to, both for students and Sigma Pi Sigma members. While the event itself will take place over just three short days in Providence, Rhode Island, the spirit of the Sigma Pi Sigma congress lives on through its members, chapters, and traditions. Sigma Pi Sigma is built on the ideals of encouragement, scholarship, service, and fellowship, and we are encouraging Sigma Pi Sigma members to take ownership of this meeting in their own way.

Many people wonder why this meeting is a “congress” rather than a “conference” or a “convention.” Historically, the meeting began as an opportunity for university students, faculty, and alumni to form a physics community, share in a common experience, voice their concerns, and examine the opportunities available to them as a collective. They then formed a society to take actions to improve departments and the lives of their members. This goal lives on through the congresses! The format and agenda of the congresses have evolved since 1928, but the event fulfills the same needs as it did back then: helping us move forward, break boundaries, and become a stronger community.

PhysCon is an opportunity to reflect on where physics fits into an ever-changing landscape and to foster connections across an increasingly diverse community. The 2019 plenary speakers span that diversity, not just in their careers (industrial physics to national labs to

academia) but in their approach and focus. The tours will introduce attendees to a range of rich experiences and open doors to potential places of future work or study. The workshops, particularly the first one of the meeting, will challenge chapters to identify the areas they are proud of and places they will strive to improve. This true meeting of the minds can break down the barriers between us to make waves within the community as we bring ideas and inspiration back to our homes. Each attendee is not just a registrant but a representative at an event designed to help guide the organization forward.

Attendees may hear the same plenary and go to the same workshops, but each person will take away something different. It is through sharing what each of us gains that we begin to learn what makes each of us unique. For those who were able to attend a previous PhysCon, please feel free to share your favorite memories with your colleagues, students, and peers, or share them on social media using the hashtag #physcon2019. For those alumni who were not able to attend, take some time to reflect on why you became interested in physics and how you might connect to your alma mater chapter or a local group in your community. Take time to share those thoughts and experiences. Whether you're a student or alumnus, start making plans now to attend. Everyone has a part to play in making PhysCon 2019 the biggest and best congress yet. We hope that you will do your part to take ownership of this historic event. ●

Travel scholarships available for students!

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2019 Physics Congress

Making Waves & Breaking Boundaries

Interactive Workshops | Scientific Tours | Plenaries
Undergraduate Poster Sessions | Career & Graduate School Fair

November 14–16, 2019
Downtown Providence, RI



Such Great Heights: Sandeep Giri

on building products, quitting academia, and putting internet in the sky

by Rachel Kaufman, Editor



Sandeep Giri spent years developing manufacturing facilities in Puerto Rico to enable the building of the giant balloons and their payloads that X (an Alphabet company, formerly Google X) needs to run Project Loon, an ambitious project to bring the internet to remote and rural areas using a network of stratosphere-based balloons.

Hurricane Maria destroyed the facility in two hours.

Undeterred, Giri (at the time Loon's manufacturing engineering manager) and his team leapt into action. Within a few weeks, they had steered enough balloons into the skies above Puerto Rico to restore connectivity for text-messaging and email to 200,000 Puerto Ricans. The newly built facilities sustained this service for months. This was an important milestone for the Loon project, which had never provided internet service at this scale before.

All in a day's work for Giri.

Born to a blue-collar family in India, Giri says he's grateful for the emphasis his parents placed on education. By chance, at a forum for Indian students interested in getting student visas to the United States, he met a professor from Coe College (Iowa) in the lobby of a Calcutta hotel. "Coe was not even on my radar. I hadn't even heard of the college or Iowa. But the professor insisted, 'Why don't you apply?'" Giri applied right in the lobby, and was subsequently accepted and offered a generous scholarship (for which he is still grateful).

At Coe, initially Giri was aiming for a computer science major. Then, by chance, he met physics professor Steve Feller, who invited Giri to his lab to work on glass research. "I had never done research," Giri says. "I had never really done experiments on fundamental science . . . That's what got me—it was totally new to me." He went on to earn his undergraduate degree in computer science and physics, and a master's in materials science; he then went on to pursue a PhD.

As Giri related in the Fall 2015 issue of the *SPS Observer*, his PhD was going well when he met a friend of a friend who was working in industry.

"[The employees there] were using the same vacuum deposition technique I was using in my grad school lab. . . . It seemed like a direct application of what I had been doing. I was like, I can use my skills to actually build a product?" He considered dropping out of school and getting to work.

It was a tough decision. His PhD results were actually "looking super interesting," and he'd just passed his qualifying exams at Stanford, which had a low pass rate. "Mentors were telling me, 'Are you sure? You're quitting a prestigious PhD at Stanford?'" But I went with my instinct that I wanted to build products."

Giri landed a job at Qualcomm, working on microelectronics devices for displays in consumer electronics, and learned "all the phases of product development." He helped develop patents for antistiction coatings for microelectronics that he eventually incorporated into their products while living in Taiwan.

After a few years, a friend recruited him to Google, where his product development experience came in handy for working on the ill-fated smart glasses known as Glass. "From our end, we did good work," he says. "It was a solid product."

After Glass wound down, Giri joined Loon. "I never thought I would work on balloons—this was an audacious idea Google was behind," he said. He developed the manufacturing engineering branch, bringing it up from scratch and launching manufacturing facilities in Nevada and Puerto Rico. The launch of balloon-based internet service to Puerto Rico after Maria was "a big win" for the project. Google is still working on further developing Loon using the Puerto Rican manufacturing facilities Giri helped build (and rebuild).

Now, surprisingly, Giri has come almost full circle to his early physics days, working on building the next generation of processors for Google's machine learning and artificial intelligence.

"These are extremely fast—some of the fastest computers in the world. I'm part of the team that helps design and build them." Giri's job is to take the next generation of the processor he works on from concept to full production, managing a chip design team, mechanical design team, manufacturing team, and so on.

The chips, called TPUs or "tensor processing units," are specialized to do a massive amount of computations per second to enable Google products to recognize spoken words, identify objects in photos, or even pick up on the emotional subtext of a written sentence.

Individuals and researchers can even rent a chip—or a "pod" of 64 chips—by the hour to work on their own projects. Google says the pods are already improving training times for machine learning models by a factor of 1,000.

And those are just the chips that are already "out there" in the world. Giri says that the hardware he's currently working on won't be released, even internally, for another two or three years. "And then Google teams will want to tinker with it." Consumers won't see the results of how the new chips are improving their phones and web apps for five to ten years. "It's very cool stuff, I can tell you that much," he says.

All in a day's work. ●

Alphabet's X "moonshot factory" received permission from the United States FCC to deploy Project Loon in Puerto Rico. Credit: iLighter Flickr (CC by SA 2.0).

Energizing Change: Ellen Williams

by Rachel Kaufman, Editor

Ellen D. Williams has a storied career in surface statistical mechanics, nanoscience, and energy technology.

Next fall, the former head of the Advanced Research Projects Agency-Energy (ARPA-E) is bringing her wisdom, experience, and climate optimism to PhysCon to inspire the next generation to use their physics knowledge to solve the world's most pressing energy problems.

Climate change "is very scary, [but] I have to be optimistic. We can do it—and we just have to do it," Williams says.

In a way, coming back to energy innovation—both at ARPA-E and in her post-ARPA-E career—is coming full circle for Williams, who was very excited about environmental issues way back in high school. But as an undergraduate, she became "more oriented toward physical chemistry," and eventually, surface science. Her research at the University of Maryland focused on studying the growth of materials used in semiconductors.

For decades she did this work, racking up numerous publications, awards, and honors along the way. Then in 2010, BP came knocking.

"I was invited to apply for the position of chief scientist at BP, and I thought, 'How could I possibly do that?' And then I thought, 'Maybe I could.'" Williams was still interested in energy and climate change, and at the time, BP was investing in solar and biofuels, so it seemed like a match. During her tenure at BP, Williams ran a sustainability initiative at the company and led the creation of reference publications on oil and gas's impact on the environment, specifically on water, land, and scarce materials, in addition to climate change.

In 2014, Williams was tapped by Ernest Moniz, then the US secretary of energy, to head up ARPA-E, the DOE's agency focused on identifying and funding cutting-edge energy technologies. "It's a great agency, it was a wonderful job. I had an incredibly productive time there," she says.

It's harder than it sounds to identify new energy tech. "The energy field is a very old field," she says, "and basically everything you could possibly imagine has been tried—and failed for one reason or another. So the big question is whether there is a new approach, something we could do now that we couldn't do in the past, that's going to work this time."

As director she oversaw the creation of new grantmaking programs such as ROOTS (Rhizosphere Observations Optimizing Terrestrial Sequestration), a program to develop technologies to monitor roots from above the ground. Researchers hope to develop plants that can sequester carbon deep underground in their roots, but without a way to monitor what's going on deep in the earth, it's hard to know if the strategies are working.

That program is ongoing, though with practical, applicable results years away. Other projects are bearing fruit. Makani Power, a project to harness electricity from kites which is now part of the Google offshoot X, received investment from ARPA-E years ago and is now being commercialized. But at the time that Makani asked for money, its proposal "was really actively discussed with the thought, Is this too far out?" Williams says.

Yet other technologies are even more surprising. Williams describes a coating developed by Stanford scientists, now being commercialized under the name SkyCool Systems, that is so reflective that using the principles of radiative cooling, it actually gets cooler under the sun. "Twenty years ago I would have said, 'That's not possible.' And now . . . we can just do so many more things now than we used to be able to do."

With the change of administration in 2016 came another job change, and Williams found herself back at UMD, teaching, researching, and consulting on energy technology innovation. "It was actually a bit of a surprise [to be back in the energy research field]" after all these years, she says. "I went away from that path [but] it never left me. But the skills I developed through my life made it possible for me to make that transition," she says. In addition to teaching, she's serving on the Maryland Energy Innovation Initiative's advisory board, helping Maryland energy companies jumpstart their technologies.

Williams recommends undergraduates focus on developing skills, even if they don't seem to connect immediately. "Find the things that excite you and that you can do well, and get really good at them," she says. "And then you can take those skills and go out and find the problems where you can have an impact." ●



Photo courtesy of Ellen Williams.

Dr. First: Jami Valentine Miller

by Rachel Kaufman, Editor



Photo courtesy of Jami Valentine Miller.

It can be lonely being the first. But Jami Valentine Miller—the first African American woman to get a physics degree from Brown University and the first African American woman to get a PhD in physics from Johns Hopkins University—is used to being the first.

Thanks to her work founding African American Women in Physics, other “firsts” may feel a little less lonely.

Miller was born in Philadelphia, where she realized her aptitude for math at an early age. This led her to a middle school magnet school for math and to a high school program that gave her college prep over the summer.

After those experiences, “I knew I was going to major in a science or engineering field,” Miller said. “It felt completely natural. It didn’t feel at all odd to be a black girl in Philadelphia who wanted to [do that].”

At a college fair at her high school, she was recruited to a historically black college and university (HBCU), Florida A&M University, where she earned a BS in physics. At the time, FAMU didn’t have a graduate program in physics, so she went to Brown for her master’s, then Johns Hopkins for her PhD.

“One of the things HBCUs do is they prepare you for life in the real world,” Miller said. “In the real world, you’re not going to be in a situation that’s 95% minority. [At Brown], I made friends, I socialized. It was definitely a culture shock because Tallahassee is not Providence. . . . It was different, but I was prepared.”

Fast-forward seven years, and Miller was just finishing her dissertation in materials for spintronic applications.

“I always wanted to do something more on the applied side. When I got to Hopkins, one of the labs that piqued my interest was with C. L. Chien.” His lab, which focused on magnetic materials and applications, had recently developed a method of using point-contact Andreev reflection to determine whether a material can retain electron spin information. Miller set to work using that method to examine whether dysprosium or gadolinium could do so. If so, those elements could be used in magnetic tunnel junction devices, which could someday replace silicon in computers, making our phones, laptops, and hard drives smaller and cheaper.

She had almost finished when her advisor insisted she get a job lined up before defending. She applied to as many positions as possible—and heard back from the US Patent and Trademark Office.

“It was eight months of paid training. I was like, ‘I’ll take this job while I wait to hear back from my true passion—a postdoctoral position.’” But patent examining turned out to be Miller’s dream job, and she’s still there, examining patents for semiconductor devices. “I enjoy the work, [and] it’s related to my dissertation.”

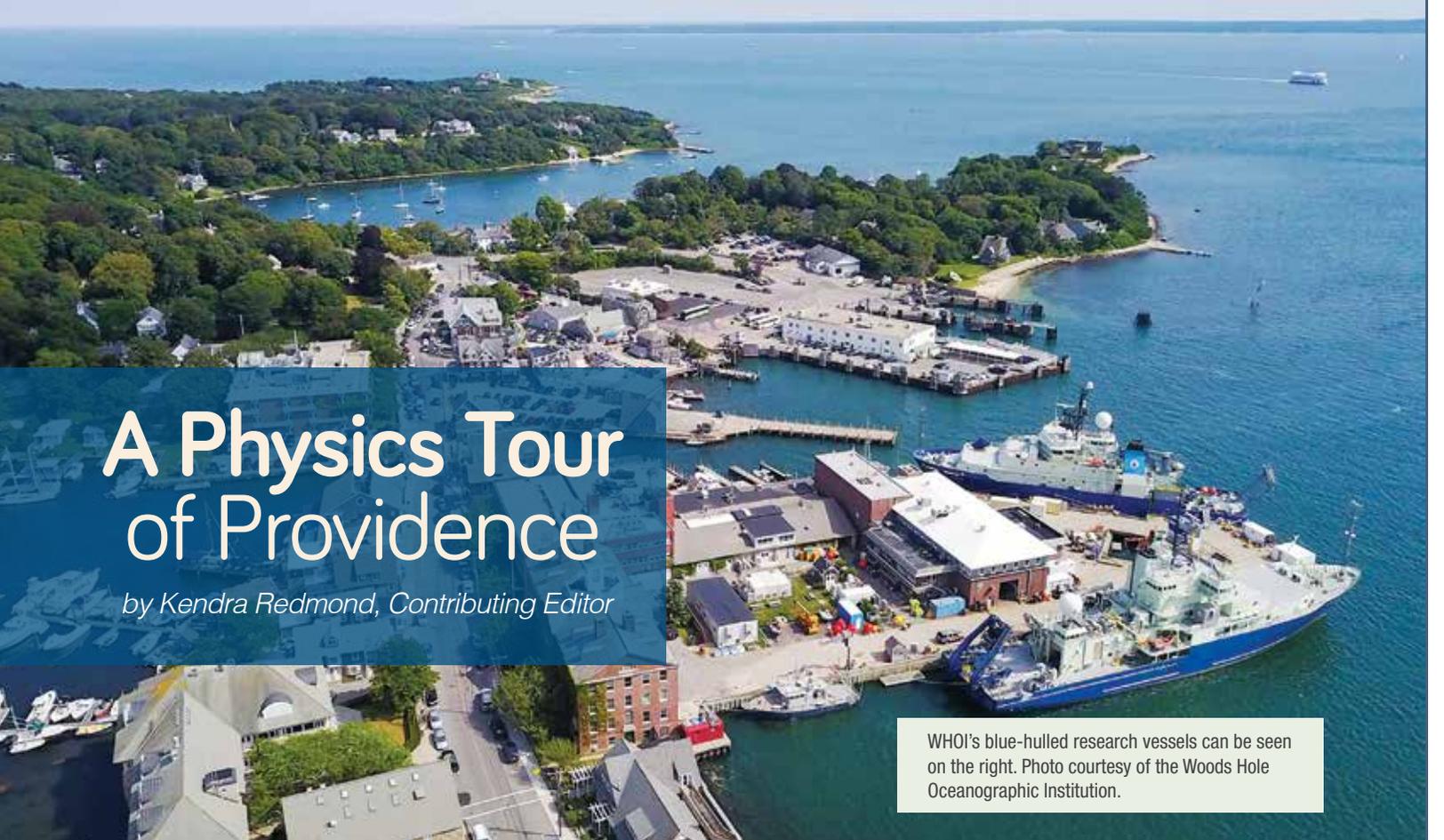
At the same time she was finishing her dissertation, Miller became acutely aware of how few other black women she knew in physics, and she started an Excel spreadsheet to track the few she knew of.

“At the time there were less than 50. I’d meet these women at different conferences [and track] who they were, what were their careers. I posted it on my website at Hopkins.” That Excel sheet eventually grew into African American Women in Physics (<http://aawip.com/>), a site to celebrate African American women “who are doing amazing things,” Miller says. “It’s also a safe space where people can discuss their concerns or any situations they might be in, because most people are going to be the only African American woman—possibly the only African American or the only woman [in their program].”

The women trade advice on navigating careers and “talk about what it’s like to be the first” African American woman in their program. “If you didn’t go to Stanford or Howard, you were probably going to be the first,” Miller says.

Now, Miller is celebrating the accomplishments of these women while also showing that physics is central to everything. At PhysCon, when she returns to the city where she got her master’s, she’ll discuss how physics and intellectual property are related.

“I’m biased,” she says, “but everything is physics. If you want to be an electrical engineer, all you have to do is figure out the vocabulary . . . because they’re still doing physics, they’re just calling it something slightly different. . . . Even if you’re just [building a] table, a table has to be balanced. There’s physics in there. If you’re interested in it, go for it.” ●



A Physics Tour of Providence

by Kendra Redmond, Contributing Editor

WHOI's blue-hulled research vessels can be seen on the right. Photo courtesy of the Woods Hole Oceanographic Institution.

Physics research encompasses a rich, diverse set of subfields and specialties that span length and time scales. PhysCon 2019 will bring together physics students, alumni, and distinguished guests to explore where the newest technologies meet the earliest formations, the depths of the universe meet the depths of the oceans, and where basic research meets consumer-driven product development.

To bring these intersections to life, PhysCon will include scientist-guided tours of regional physics hotspots including a cutting-edge optical engineering firm, a historic observatory, a leading ocean research nonprofit, and a nuclear submarine port. If there is a downside to these tours, it's that there will not be nearly enough time to explore all of the fascinating research happening at each site, or at the sites whose tour details are still forthcoming—Harvard University, the Massachusetts Institute of Technology, and the Rhode Island Hospital. Stay informed and register early to get your pick of tours: <http://www.sigmapi sigma.org/sigmapi sigma/congress/2019>.

Optikos: The Optical Engineering Experts

"I've touched something that's been to space, that's been in the human body, that makes the maps for smartphones—anything that you can think of that has a lens, and even the things that you can't think of," says Optikos engineer Henry Donaldson.

Optikos is a private company specializing in optical engineering and metrology. That might sound like a niche market, but precision optics is an enabling technology for everything from self-driving cars to medical diagnostics and virtual reality headsets, and precision optics requires precise measurement capabilities. The company works with commercial, industrial, and government clients on projects that include not only measurement systems, but also prototype development, design for manufacturing and sub-assembly production.

Donaldson works in IQ Lab™ Services, a group that measures the quality and characteristics of optical systems for clients. "I see something new every day, the newest of the new," he says. Many systems are so novel and unusual that IQ Lab engineers have to design and build custom measurement tools for these devices. Their clients come from all industries and all over the world. In the two years since he earned a physics bachelor's degree and joined Optikos, Donaldson has installed sophisticated metrology systems in Spain, China, and Hong Kong.

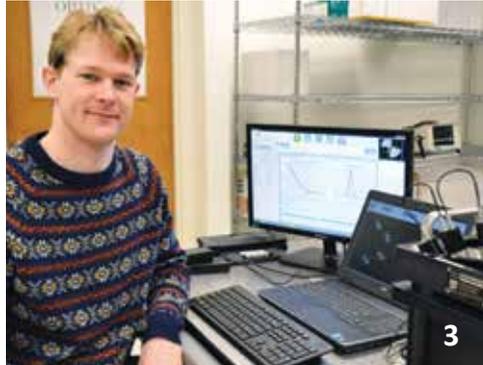
The company has about 65 employees, primarily optical, optomechanical, and electrical engineers and technicians. It's a focused, hardworking culture according to Donaldson. "It's like a 36-year-old startup," he laughs, "but not a West Coast startup—people are rolling up their sleeves and getting their hands dirty."

Ladd Observatory: A Lesson on the Passing of Time

After 127 years, the once-modern refracting telescope at Ladd Observatory maneuvers via its original counterweight-driven gear drive to reveal the wonders of the night sky. This makes Ladd one of the few 19th-century observatories with its main telescope still in original condition, says Brown University physics professor Ian Dell'antonio.

The telescope, with a 12-inch aperture and 15-foot focal length, provides visitors with a unique perspective of space and the passage of time. "If it's clear, the optics of the telescope permit great views of the moon and planets. The sky is a little bright—Ladd used to be alone on top of the hill, but in the last 100 years Providence has engulfed it," says Dell'antonio.

In its early days the observatory marked time in another important way. From 1893 to 1916, Ladd kept time using stellar observations and sent out a time signal to the city of Providence. Although radio signals from the US Naval Observatory usurped this role in 1916, Ladd sent time signals to local fire and police departments through the early 1970s. The observatory now has a unique collection of historical clocks, regulators, and other instruments.



- 1: WHOI workers assemble a surface buoy for use in the Ocean Observatories Initiative, an effort to collect 25–30 years of ocean data for monitoring and analysis. Photo courtesy of the Woods Hole Oceanographic Institution.
- 2: A US Navy Los Angeles class fast-attack submarine participates in an exercise with Japanese forces. Photo by Navy Chief Petty Officer Robert Gulini. *The appearance of US Department of Defense (DoD) visual information does not imply or constitute DoD endorsement.*
- 3: Optikos engineer Henry Donaldson. Photo courtesy of Optikos.
- 4: A US Navy sailor trains in the submarine escape trainer at the Navy Submarine School on Naval Submarine Base New London. Photo credit: DoD. *The appearance of US Department of Defense (DoD) visual information does not imply or constitute DoD endorsement.*
- 5: Ladd Observatory. Photo by Michael L. Umbrecht / Ladd Observatory.

Today, Ladd is primarily used by Brown University students studying the history of astronomy and celestial navigation, and for public observing events. In addition to the refracting telescope in the main tower, there is a transit room with two transit telescopes and a pier that holds a modern 10-inch reflecting telescope, weather station, and an all-sky camera.

Woods Hole Oceanographic Institution: “Understanding the ocean. For our planet and our future.”

“The ocean is a defining feature of our planet, and crucial to life on Earth, yet it remains one of the planet’s last unexplored frontiers,” begins the vision statement of the Woods Hole Oceanographic Institution (WHOI), a large independent research facility located in Woods Hole, Massachusetts, the site of a protected deepwater harbor.

WHOI researchers are at the forefront of this exploration—studying the physics, chemistry, biology, and geology of the ocean and its role in climate change. They work on land and at sea, observing, documenting, and modeling aspects of the ocean and its connection to the earth. Many are physicists that apply their knowledge to studying ocean processes and designing instruments and robots that can withstand the extreme conditions found in the depths of the ocean.

Along with lab spaces, WHOI operates two large research vessels and several smaller watercraft and autonomous vehicles based at the harbor. *Atlantis* and *Neil Armstrong*, the large vessels, have permanent crews that take groups of scientists out to sea to collect samples, deploy instruments, or carry out other research activities.

One of the key features of the institution is that scientists have the freedom to set the course for their own research, according to senior scientist Larry Pratt. “It’s very different from a corporate environment, with an immediate boss and set daily hours,” he says. Some researchers are seagoing, and others work on water tank experiments, design instruments, or develop computer simulations. Some are even engaged in debris location efforts—WHOI scientists helped discover the *Titanic* and a large portion of the wreckage from Air France Flight 447.

Naval Submarine Base New London: Home of the Submarine Force

The Naval Submarine Base New London is home port to 15 US Navy attack submarines—stealth operators designed to locate and destroy enemy submarines and ships, conduct surveillance, carry special operation forces, and engage in other warfare activities.

The submarines are fantastic feats of physics and engineering. Powered by nuclear energy, they utilize some of the most advanced data-gathering and weapons technologies in the world—even while operating more than 800 feet below the surface. In the newest submarines, traditional periscopes are replaced by photonics masts with visible and infrared digital cameras on telescoping arms.

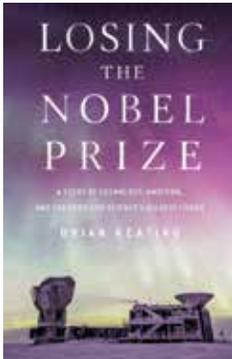
The base also houses the primary training grounds for submariners, including facilities for fire management and a 40-foot-high pool for deepwater escape training. A medical research lab on campus studies how the undersea experience impacts humans. The USS *Nautilus*, the first nuclear-powered submarine, is moored near the main gate of the adjacent Submarine Force Library and Museum. *Nautilus* launched from the base in 1954 and is now a National Historic Landmark. The base also neighbors the General Dynamics Electric Boat’s main construction yard where most of the US Navy submarines are built. ●



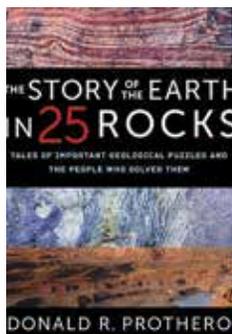
Five Books about **Physics** That Stood Out in 2018

by Melinda Baldwin, Senior Editor, *Physics Today*

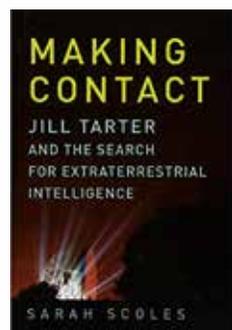
Every month *Physics Today* prints reviews of new books on the physical sciences. As the lucky person who gets to sort through the incoming books and then edit the reviews, I read a lot of fantastic stories about science and the people behind it. Here are five books that got rave reviews in the pages of *Physics Today* last year. I've also included five bonus picks from our New Books & Media column, which covers not just books but films, podcasts, software, television series, and more.



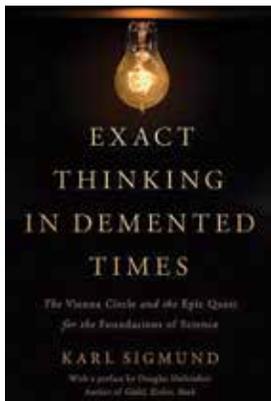
***Losing the Nobel Prize: A Story of Cosmology, Ambition, and the Perils of Science's Highest Honor* by Brian Keating (W. W. Norton, 2018, \$27.95).** In March 2014, a team working on the BICEP2 telescope announced the detection of a polarization signature consistent with primordial gravitational waves. Newspapers and magazines around the world covered what seemed to be confirmation of cosmic inflation, and a video of BICEP2 scientist Chao-Lin Kuo surprising theorist Andrei Linde with news of the discovery went viral. But within a year it became clear that BICEP2's signal had been caused not by gravitational waves but by cosmic dust. In *Losing the Nobel Prize*, BICEP2 collaborator Brian Keating reflects on what went wrong. He contends that the BICEP2 team rushed its announcement in its eagerness for the coveted Nobel, a prize that harms science, he asserts, by encouraging cutthroat competition and an urgency to claim credit. Cosmologist Lloyd Knox said the book is "a compelling personal memoir, a fascinating history of cosmology, and an interesting firsthand account of a dramatic scientific adventure."



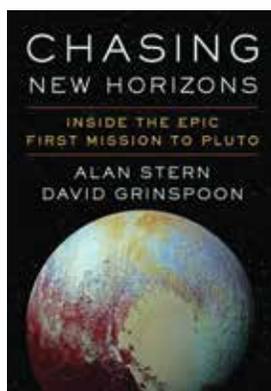
***The Story of the Earth in 25 Rocks: Tales of Important Geological Puzzles and the People Who Solved Them* by Donald Prothero (Columbia Univ. Press, 2018, \$35.00).** Geologist and paleontologist Donald Prothero looks back at the history of his discipline through 25 short essays about famous geological puzzles. Prothero tackles continental drift, the origins of volcanoes, the cycles of ice ages, and more in his chapters, focusing on moments when unexpected or unexplained findings raised new questions that led to breakthroughs. He also calls attention to both well-known geologists like Charles Lyell and ones who are more often overlooked, such as former janitor James Croll. Earth scientist Michael Manga called the book "engrossing" and recommended it "to anyone interested in tales of scientific discovery and natural marvels."



***Making Contact: Jill Tarter and the Search for Extraterrestrial Intelligence* by Sarah Scoles (Pegasus Books, 2017, \$27.95).** Science writer Sarah Scoles's first book tells the story of Jill Tarter, an engineer and radio astronomer who has devoted her scientific career to SETI. Tarter, famously the inspiration for the main character in Carl Sagan's novel *Contact*, has been an influential member of the SETI project since its earliest days. The lively biography follows Tarter from her days as a student at Cornell and into her pioneering career searching for signs of extraterrestrial life. Scoles, a longtime admirer of Tarter's work, also highlights the way she has mentored and inspired female scientists. Shelley Wright praised Scoles's skilled handling of both biographical and scientific details and said the book "will engage both amateur science enthusiasts and the most seasoned physicists."

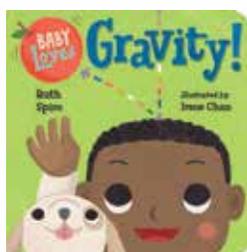


Exact Thinking in Demented Times: The Vienna Circle and the Epic Quest for the Foundations of Science by Karl Sigmund (Basic Books, 2017, \$32.00). In his latest book, Viennese mathematician Karl Sigmund follows the lives and careers of the members of the Vienna Circle, a group of philosophers and physicists whose work underlies the modern philosophy of science. The group began its work in a Vienna that was one of Europe's brightest intellectual centers, but the rising tide of European fascism and anti-Semitism would eventually disband it. Some members found new intellectual homes outside Austria; others met less congenial fates. Most tragically, founding member and leader Moritz Schlick was assassinated by a mentally ill former student; Nazi leaders praised the murderer for killing a "friend of the Jews." Historian Don Howard expressed high praise for Sigmund's book, calling it "serious and first-rate history—written like a novel."

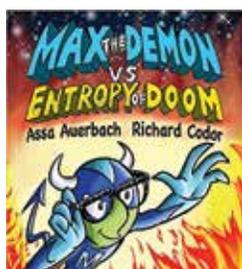


Chasing New Horizons: Inside the Epic First Mission to Pluto by Alan Stern and David Grinspoon (Picador, 2018, \$28.00). The *New Horizons* spacecraft completed a flyby of Pluto in July 2015, sending back our first images of the ex-planet's icy surface. In this engaging book about the mission, principal investigator Alan Stern and planetary scientist David Grinspoon chronicle the long efforts to launch a probe to Pluto. The book is accessible to general readers but also contains an appendix that describes the mission's findings in enough scientific detail to engage seasoned planetary scientists. Astronomer Jim Bell said the book is "a comprehensive, entertaining, and educational story about the birth, glorious prime of life, and continuing adventures of a unique mission to the farthest realm of our solar system."

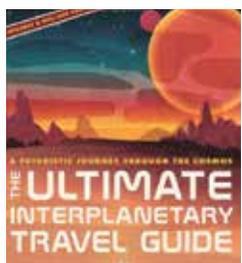
New Books & Media Picks



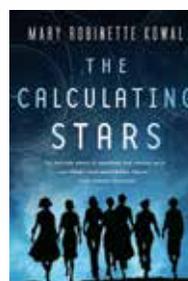
Baby Loves Gravity! by Ruth Spiro, with Irene Chan, illustrator (Charlesbridge Publishing, 2018, \$8.99). For the smallest kids on your list, consider this colorful board book, which shows how gravity's pull affects Earth's movement around the Sun and a trip down a slide at the park.



Max the Demon vs. Entropy of Doom by Assa Auerbach and Richard Codor (Loose Line Productions, 2017, \$24.95 paperback). This innovative graphic novel aimed at middle and high school students follows nerdy superhero Max the Demon and his scientist friend Julie Calore as they try to fight climate change and develop alternative energy sources.



The Ultimate Interplanetary Travel Guide: A Futuristic Journey Through the Cosmos by Jim Bell (Sterling, 2018, \$24.95). Astronomer Bell's lively book imagines a future in which vacationers plan trips to solar system destinations such as Pluto and Europa.



The Calculating Stars and The Fated Sky by Mary Robinette Kowal (Tor, 2018, \$18.99 paperback/\$15.99 paperback). This pair of novels explores an alternate history of spaceflight in which humanity races to escape the catastrophic consequences of an asteroid strike.

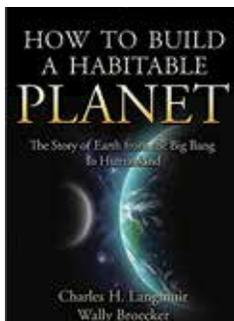


One Strange Rock (Nutopia, 2018, \$29.95 DVD). The National Geographic Channel's ten-episode miniseries combines stunning footage of unusual natural phenomena and insightful interviews with astronauts to explore the serendipity of life on Earth. Will Smith narrates. ●



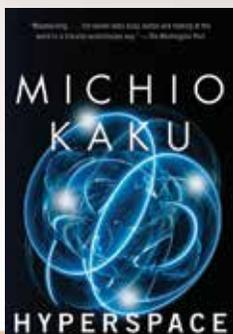
What's on Your Bookshelf?

We asked Sigma Pi Sigma members, What are some of the books that have had an impact on your science journey? There were many of the books you'd expect (e.g., “*Surely You're Joking, Mr. Feynman!*”: *Adventures of a Curious Character* and Stephen Hawking's *A Brief History of Time* from the nonfiction side, and *Ender's Game* and *The Hobbit* from the fiction camp) and a healthy number of textbooks, but several of you also suggested books that may be a little further back on the shelves. Enjoy this sampling—maybe you'll find some good ideas for your 2019 reading list.



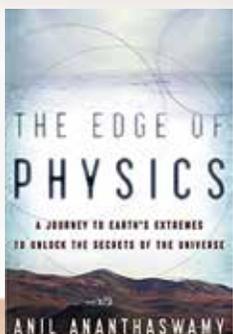
Douglas Arion (inducted at Carthage College in 2007), professor of physics, astronomy and entrepreneurship at Carthage College and the president of Galileoscope LLC, uses *How to Build a Habitable Planet: The Story of Earth from the Big Bang to Humankind* by Charles H. Langmuir and Wally Broecker as the core reference for his public outreach program.

He notes, “No other book covers the history of the Universe, with all the physics, chemistry, and biology . . . If you don't understand where it all came from, and why it works the way it does, how can you study or understand anything else?!” He also praises it as well written and highly approachable for a range of audiences.



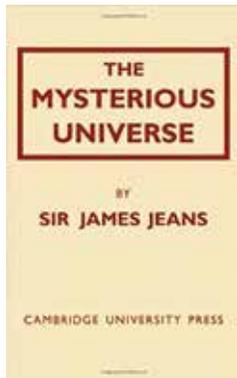
Many readers can likely identify with **Lisa Genovese** (Grand Valley State University, 2009) who could only understand about 10 percent of the content the first time she read *Hyperspace: A Scientific Odyssey Through*

Parallel Universes, Time Warps, and the 10th Dimension by Michio Kaku. She borrowed the book from her brother's bookshelf, and it sparked her love of physics. Lisa is now a diagnostic medical physicist for a consulting firm in Maryland.



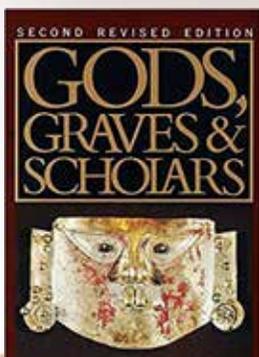
The Edge of Physics: A Journey to Earth's Extremes to Unlock the Secrets of the Universe by Anil Ananthaswamy is the only book that **Edwin Ward** (Colby College, 2016) has found that “investigated a scientific field through the perspective of the tools used to study it.” Currently a law student at the George

Washington University, Ward is on a mission to find as many additional copies of the book as he can to share with others interested in reading about science. This is a book that “walks the fine line between educating the armchair scientist while maintaining the interest of the professional one.”



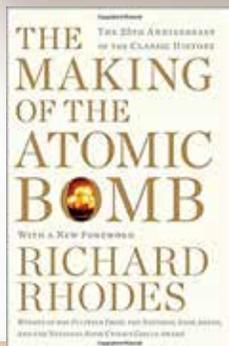
Two APS Fellows, **Kenneth W. Ford** (Honorary, 2000), the retired executive director of the American Institute of Physics, and **Ronald E. Mickens** (At-Large, 1966), the Distinguished Fuller E. Callaway Professor of Physics at Clark Atlanta University, cited Sir James Jeans's *The Mysterious Universe* as a transformative piece of nonfiction from their childhoods. Mickens notes that as a young African American in Virginia in the 1940s and '50s he had limited access to books in the segregated public library. He tells the tale of finding this particular

book in the catalog: "Opening it and examining its pages at random, I saw symbols not seen before and discussions of topics unknown to me. Over a period of several months, I read and reread this volume, understanding little of the discussions on quantum mechanics and relativity. However, I was determined to do what was needed to one day fully comprehend its contents. This was the beginning of my serious journey into science. The book was never returned . . . but that is a story in and of itself." Dr. Mickens's secret is safe with the countless Clark Atlanta physics graduates who benefited from his scholarship.



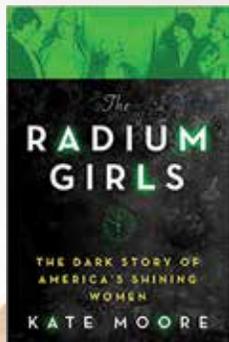
Renowned astronomer **Virginia Trimble** (Oglethorpe University, 1993) credits her love of science with two books from outside the physical sciences. She recalls reading *Gods, Graves, and Scholars: The Story of*

Archaeology by C. W. Ceram and the genetics primer *You and Heredity* by Amram Scheinfeld over ten times as a child. They left an indelible mark on her and stoked a lifelong curiosity for science.



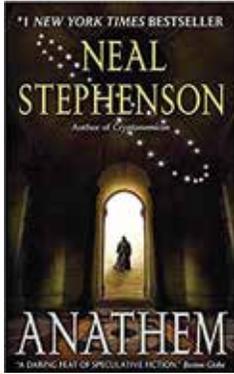
Joshua Frey (Ripon College, 2009), a US Army nuclear and counterproliferation officer with a self-professed "substantial reading problem," describes *The Making of the Atomic Bomb* by Richard Rhodes as a text that "should serve as both an engaging primer on the basic science

and on how government decision-making is supported by, and may go counter to, the advice of scientists." This Pulitzer Prize-winning book is in the canon for those interested in the history of nuclear weapons and the Manhattan Project.



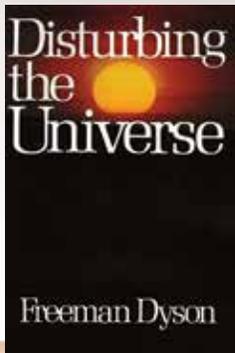
One of the more recently published books recommended is *The Radium Girls: The Dark Story of America's Shining Women* by Kate Moore. The book is written from the perspective of the women in their 20s who basked in the coveted jobs working in radium dial factories

until the element's poisonous effects took hold. **Brittney Hauke** (Coe College, 2016), a graduate student in materials science at Arizona State University, sees this book as a critical reminder of "why scientists need to make our discoveries available to the general public."



Fiction selections weren't as prevalent on our readers' lists, but **Terri Gilbert** (New Mexico Institute of Mining and Technology, 1991), a neuroscientist building a data/analysis repository for translational brain health, offered *Anathem* by Neal Stephenson. While she notes that Stephenson's use of language can be somewhat disorienting at first, if you let yourself

get immersed in the book it is "a means to allow your mind to understand concepts in string theory and alternate universes that seem inaccessible" on the surface. Stephenson's postapocalyptic tale features mathematicians, scientists, and philosophers who live in isolation from the public until their assistance is required to solve a mind-bending crisis.



Fans of Ed Neuenchwander's Elegant Connections column in *Radiations* will recognize the name Freeman Dyson as a significant influence on Neuenchwander's writing and a frequently cited source. **David Cornell** (Principia College, 1984), a retired professor who now

tutors online, praises Dyson's *Disturbing the Universe* as capturing how "the universe and man interact through the wholeness of being, including our scientific and cultural selves, the latter characterized by love of music, arts, and books."

For those of you bibliophiles who are interested in digging a little deeper, check out the Niels Bohr Library & Archives' new blog *Ex Libris Universum* (<http://bit.ly/ExLibrisAIP>). The blog features AIP's recently acquired Wenner Collection of rare books. The collection contains writings on the most important discoveries in physical sciences over the past four centuries. The 3,800 volumes were carefully curated over a 25-year period by David Wenner and feature works by Ptolemy, Galileo, Huygens, Halley, Newton, Curie, Laplace, and more.



Have a book you'd like to recommend to your fellow Sigma Pi Sigma members? Email us at sigmapisigma@aip.org.



Collection favorites. Photos by Margaret Landis.

From the Shadows to the Shelf: A Collection of Books on Women in Science

by Margaret Landis, Sigma Pi Sigma Member,
Northern Arizona University 2011, & Postdoctoral
Researcher at the Planetary Science Institute

I have always been a reader. When I was deciding to become a space scientist, I indiscriminately read as many popular biographies of scientists as I could, including a biography of astronomer Henrietta Swan Leavitt.

My systematic interest in books about women and minoritized groups in STEM started after I attended a Conference for Undergraduate Women in Physics (CUWIP). The institution represented by the most attendees that year got a copy of *Out of the Shadows: Contributions of Twentieth-Century Women to Physics* for the departmental library. Northern Arizona University (my institution) won. I ended up buying my own copy of the book and was amazed at how many women who made significant contributions to physics were left out of my undergraduate textbooks. I wondered if this had happened or was happening elsewhere in STEM.

Reading about the history of women in science not only helped me realize what my future could look like, but also that women, and especially women of color, have made major contributions to physics that are routinely neglected in physics classes. Furthermore, I realized that the science contributions of women

have often been intentionally minimized. I started a book collection, now numbering more than 30 volumes and growing, with the goal of building an inclusive and representative reading list for myself and for students who struggle to see themselves as scientists.

This year my collection received an honorable mention from the Honey and Wax Book Collecting Prize, which recognizes outstanding book collections conceived and built by young women. If you're looking for your next read, I encourage you to consider some of my favorites among those still in print. ●

Code Girls: The Untold Story of the American Women Code Breakers of World War II by Liza Mundy (Hachette Books, 2017, \$28.00).

American Eclipse: A Nation's Epic Race to Catch the Shadow of the Moon and Win the Glory of the World by David Baron (Liveright, 2017, \$27.95).

The Glass Universe: How the Ladies of the Harvard Observatory Took the Measure of the Stars by Dava Sobel (Viking, 2016, \$30.00).

Hidden Figures: The American Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race by Margot Lee Shetterly (William Morrow, 2016, \$27.99).

Rise of the Rocket Girls: The Women Who Propelled Us, from Missiles to the Moon to Mars by Nathalia Holt (Little, Brown, and Company, 2016, \$27.00).



Reflections on the 2016 Congress Theme: *Unifying Fields—Science Driving Innovation* Thoughts on Innovation and the Human Spirit

Dwight E. Neuenschwander

”

‘What’s new?’ is an interesting and broadening eternal question, but one which, if pursued exclusively, results only in an endless parade of trivia and fashion, the silt of tomorrow. I would like, instead, to be concerned with the question ‘What is best?’

—Robert Pirsig¹

“



Shelter Island Conference, June 1947 (Emilio Segrè Archive, AIP). The Shelter Island participants are our heroes, but we’re glad to see lively diversity today (right), such as these 2016 congress attendees touring SLAC. Photo courtesy of Tracy Schwab.

As we look ahead to the 2019 Sigma Pi Sigma Congress, I have been asked to “explore and expound” on the *Unifying Fields: Science Driving Innovation* theme of the last congress, held in San Francisco, California, in 2016. The events of the 2016 congress are well chronicled elsewhere,² but I cannot resist adding that the meeting was fabulous. For instance, the dance party sponsored by the American Physical Society exploded stereotypes of the dour physicist in a rumpled suit (see above).

In fulfilling my assignment, hopefully my lack of profundity is offset by the 2016 congress being my seventh consecutive one. Being a geezer offers the advantage of experience. Experience means having a past to compare with the present. Most of my students today have never lived in a world without cell phones, word processors, or the Internet. For example, they never had the pleasure of typing a term paper on a mechanical typewriter—with the additional fun of inserting math symbols

1. Robert Pirsig, *Zen and the Art of Motorcycle Maintenance: An Inquiry into Values* (William Morrow & Co., 1974), 16.

2. See the Fall 2015, Spring 2016, Fall 2016, and Spring 2017 issues of *Radiations*.

and Greek letters by hand. My old Royal typewriter still works, but now I prefer to use a word processor, which I deeply appreciate because I have an alternative for comparison. On the other hand, I still respect the Royal—it needs no software upgrades, it consumes no electricity, and by looking at it closely one sees the clever design of its mechanical action. There is something to be said for simplicity.

“Unifying fields” as a source of innovation was beautifully illustrated several years ago by Carl Sagan. He invited readers to imagine Queen Victoria commissioning in 1860 a cost-is-no-object “Westminster Project” to design and build a communication system that would, in real time, carry voices and pictures into every home of the British Empire—not through wires, but “somehow come out of the air.” However, Sagan said, “The Westminster Project would almost certainly fail. Why? Because the underlying science hadn’t been done.”³ A theory of the electromagnetic field did not yet exist. Maxwell’s equations in 1861 and 1862 unified electric and magnetic fields into one. Only by grasping that unity could radio and television be conceived as applications. Of course, they did not spring forth the moment Maxwell’s equations appeared but had to await the development of complex technologies such as vacuum-tube amplifiers and television picture tubes. That long road from initial concepts to marketable products took armies of highly skilled people solving tricky technical problems.⁴

Quantum mechanics was invented to unify our understanding of microscopic phenomena. Semiconductor electronics were among its serendipitous applications. The prototype transistor, built in 1948, had been envisioned since 1939 as a theoretical possibility, thanks to the concept of quantum mechanical tunneling. Turning that visionary idea into mass-produced transistor radios, personal computers, and cell phones was another long and difficult road. In Jon Gertner’s history of Bell Labs, he writes, “In later years, it would become a kind of received wisdom that many of the revolutionary technologies that arose at Bell Labs in the 1940s and 1950s owed their existence to dashing physicists such as Bill Shockley, and to the iconoclastic ideas of quantum mechanics ... More fundamentally, however, the coming age of technologies owed its existence to a quiet revolution in materials. Indeed, without the new materials ... Shockley would have spent his career trapped in a prison of elegant theory.”⁵ Gertner explains that in the flood of postwar technology, the term “innovation” came to mean “the lengthy and wholesale transformation of an idea into a technological product (or process) meant for widespread practical use. Almost by definition, a single person, or even a single group, could not alone create an innovation.”⁶ Innovation requires a deep bench of diverse skills and perspectives.

Ralph Brown, the Bell Labs research director when the transistor was invented, said that if the lab’s buildings, equipment, and records were destroyed but the people remained, the lab would still exist. But if the people left and the infrastructure remained, the lab would not exist. Gertner summarizes, “Bell Labs was a human and not a material

organization. . . . Brown never explained whether the institution’s success was a result of thousands of engineers and scientists working together, or of the few exemplars who towered above everyone else.” After thoughtful consideration Gertner concludes, “Perhaps the most significant thing was that Bell Labs had both kinds of people in profusion, and both kinds working together. And for the problems it was solving, both kinds were necessary.”⁷ The technical and socioeconomic challenges facing the world today—for example, the wicked problem of transitioning fossil-fuel-based economies to clean energy—will require exemplars and deep benches. As the closest thing the physics community has to an alumni association, Sigma Pi Sigma provides a big-tent network for crucial players—our hidden and explicit physicists. With their technical competence and cultural perspectives, Sigma Pi Sigma members should lead the way in keeping innovation “a human and not a material” enterprise.

The 2016 congress theme of unity and innovation built on previous congress themes. The 2012 congress, held in Orlando near the Kennedy Space Center, emphasized *Connecting Worlds Through Science and Service*.⁸ In 2008 at Fermilab, with its inspiring legacy of neighborly citizenship,⁹ congress attendees discussed *Scientific Citizenship: Connecting Physics and Society*.¹⁰ The 2004 congress theme, *Heritage and Promise*, linked physics and society through discussions of scientific ethics.¹¹ Resolutions on ethical scientific conduct were passed—a fitting task when meeting in Albuquerque, halfway between Los Alamos and the Trinity Site, geographical reminders that innovations present their authors with ethical dilemmas, with results that are thrust onto society. The 2000 congress in College Park solicited member feedback through the working theme *What Would You, As a Sigma Pi Sigma Member, Like to Tell the Physics Community?*¹² The 2000 congress expanded on the 1996 Diamond Jubilee Congress theme, *Looking Back, Looking Forward*.¹³ On that 75th anniversary of the Sigma Pi Sigma’s founding, the founders were honored and the value of the society to the larger physics community was emphasized, including such steps as introducing the term “hidden physicist”¹⁴ and a mission statement with an explicit “service” component.¹⁵ As a trial run before the 1996 Atlanta, GA anniversary event, the 1992 congress in Dayton (my first one) restored

7. *Ibid.*, 357–358.

8. 2012 Congress: *Radiations* Fall 2011, Spring 2012, Fall 2012, Spring 2013, Fall 2013, Spring 2014.

9. D.E. Neuenschwander, “Fermilab: Scientific Citizenship by Example,” *Radiations*, Spring 2008, 15–16.

10. 2008 Congress: *Radiations* Spring 2008, Fall 2008, Spring 2009, Fall 2009.

11. 2004 Congress: *Radiations* Fall 2003, Spring 2004, Fall 2004, Spring 2005.

12. 2000 Congress: *Radiations* Spring 1999, Fall 1999, Summer 2000, Winter 2000.

13. 1996 Congress: *Radiations* Fall 1995, Spring 1996, Fall 1996, Spring 1997.

14. “The Origin and Future of the Term ‘Hidden Physicist,’” *Radiations* editorial (Winter 2000), 18. The Spring 1996 *Radiations* solicits “Friends of Physics” contacts, p. 17, and the first installment of the “Spotlight on Hidden Physicists” column appeared in the Fall 1996 issue, p. 38.

15. For an abbreviated version of the Sigma Pi Sigma mission statement, see <http://www.sigmapisigma.org/sigmapisigma>; for the full version see *Radiations* (Spring 1996), 20.

3. Carl Sagan, *The Demon-Haunted World: Science as a Candle in the Dark* (Ballantine Books, 1996), 384–385.

4. F.M. Smits, Ed., *A History of Engineering & Science in the Bell System: Electronics Technology (1925–1975)*, AT&T Bell Laboratories (1985), ch. 3. These earlier technologies are as interesting as the semiconductors that replaced them.

5. Jon Gertner, *The Idea Factory: Bell Labs and the Great Age of American Innovation* (Penguin Press, 2012), 81. See also F.M. Smits, ref. 4, ch. 1.

6. Gertner, ref. 5, 107.

these meetings into the culture of physics.¹⁶ The Dayton meeting asked what Sigma Pi Sigma could do for its members, and subsequent congresses asked what Sigma Pi Sigma could do for society. The 1992 congress was the first after a long hiatus dating back to the 1967 congress held at Purdue University, when Sigma Pi Sigma and the American Institute of Physics created the Society of Physics Students.¹⁷ During the following two decades while the focus fell on establishing SPS, the congresses were never out of mind.

The 2016 congress theme celebrated innovation. As scientists, we are obliged to offer constructive criticism as well. The Diamond Jubilee gave Alan Lightman the opportunity to critique our sometimes over-reliance on technology. In his plenary talk “The Curse of Prosperity,” he offered examples of “technology overload.”¹⁸ For instance, if fussing over the video camera during your 10-year-old daughter’s birthday party prevents you from seeing that irreplaceable moment in real time with your own eyes, that’s technology overload.

For better and for worse, since the 1992 congress our innovations have grown more tentacles. Nowadays I increasingly find myself asking, “Do I own my technology, or does it own me?” Our brilliant innovations leverage what can be done, but they also bring unintended consequences, enhancing and potentially diminishing the human experience.¹⁹

Being fully human includes having time to reflect.²⁰ During the first morning of the 2016 congress I went to the hotel café for a croissant and coffee. Ten large flat-screen televisions filled the span behind the counter, from one end to the other. Flat-screen TVs are elegant applied physics, and I enjoy describing to my students how they work, along with the equally interesting cathode-ray television picture tubes the flat screens are replacing. But these beautiful machines have become, by their omnipresence, invasive deliverers of technology overload. Evidently the café designers condescendingly decided *for me* that I cannot go five minutes without hearing the latest antics of the celebrities *du jour*.²¹ Such intrusions have become the norm. How did we allow silence to become

so difficult to find in modern society?²² Shouldn’t quiet be a protected resource? Shouldn’t the Bill of Rights contain an amendment upholding our right to be left in peace? The same innovations can send signals in reverse, as with data mining, GPS and keystroke tracking, digital spying by hacking, and so on,²³ hastening the evaporation of privacy. Timothy Snyder, a historian of authoritarian regimes, commented in a recent interview, “Totalitarianism starts when the difference between your public life and your private life is effaced. . . . If we can’t have a private life then we are not a free people.”²⁴ The leverage offered by recent innovations allows us to be steered from afar by anonymous forces. Efficiency should not be purchased at the price of individual serenity and freedom.

Being fully human also includes taking responsibility for one’s own well-being. Among the tours arranged for the 2016 congress attendees, I visited the Computer History Museum in the nearby town of Mountain View. The experience was well worth the hours of my life I spent there. The museum sits near Google’s headquarters. One of Google’s cute autonomous cars was on display. Its doors were open, so I climbed inside. There was no steering wheel. The promotional displays surrounding the little machine gushed the virtues of its self-driving abilities—reducing congestion and accidents, and so on, all genuine merits.²⁵ People who loathe driving or are disabled should have one of these appliances. For them, a self-driving car means freedom. Not so much for me; a Miata roadster with a six-speed manual transmission is my preferred mode of four-wheeled transportation. The autonomous car’s display extolling the virtues of my not “having to” drive left me feeling like a skier who has been given the glorious news that ski lifts will henceforth carry me back down the mountain so I won’t have to suffer the “inconvenience” and risk of doing the skiing myself.²⁶ When you stop and really think about it, smoothly

22. D.E. Neuenschwander, “Rattlesnake University,” *SPS Observer*, Winter 2002, 6–7, 14; D.E. Neuenschwander, Ed. *Dear Professor: Twenty Years of Correspondence Between Freeman Dyson and Undergraduate Students About Science, Technology, Society, and Life* (World Scientific, 2016), ch. 11.

23. “Wikileaks Documents Detail Alleged CIA Hacking Tools,” National Public Radio interview on Morning Edition, March 8, 2017, with Jake Williams of the cybersecurity firm Rendition InfoSec <http://www.npr.org/2017/03/08/519170664/wikileaks-documents-detail-alleged-cia-hacking-tools>. A recent “Quantum Information” poster produced by the Joint Quantum Institute of the University of Maryland, APS, and NIST announced, “Through massive parallel processing, quantum computers are expected to easily crack popular encryption schemes and offer faster ways of searching vast databases.” Quantum computing will give exciting insights into quantum mechanics, but are we expected to uncritically endorse this application?

24. Interview with Timothy Snyder on National Public Radio’s Morning Edition, March 6, 2017; see also Cathy O’Neil, *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy* (Crown, 2016); “Every Step You Take,” *The Economist*, Nov. 16, 2013; “The End of Privacy,” *Science Special Issue*, Jan. 30, 2015.

25. It was interesting that the display included no suggestion of any downsides or unintended consequences, such as the consequences of hacks into networked car computer systems, or operators forgetting how to drive.

26. Jamie Kitman, “Car and Driverless: Save the Steering Wheel,” *Automobile*, Nov. 2011, 22–23; Mat Honan, “The Gadgetization of Cars is Kind of Ruining Them,” <http://gizmodo.com/5815889/the-gadgetization-of-cars-is-kind-of-ruining-them>.

16. The visionary individuals who urged restoration of the congresses in time for the 75th anniversary of Sigma Pi Sigma, and worked tirelessly with AIP staff to make it happen, include former Sigma Pi Sigma presidents Worth Seagondollar and George Miner, and Sigma Pi Sigma/SPS Historian Peggy Dixon. Marsh White, in his nineties, cheered everyone on.

17. Peggy Dixon, *Sigma Pi Sigma Historical Highlights 1921–2003* (American Institute of Physics, 2003), 8–11.

18. Alan Lightman, “The Curse of Prosperity,” *Diamond Jubilee Proceedings* (American Institute of Physics, 1996), 21–27.

19. Matthew Crawford, *Shop Class as Soulcraft: An Inquiry into the Value of Work* (Penguin Books, 2009); Matthew Crawford, *The World Beyond Your Head: On Becoming an Individual in an Age of Distraction* (Farrar, Straus and Giroux, 2015); Michael Rogers, “What’s Gained, What’s Lost,” *Newsweek Special Edition* (1989), 68; Sherry Turkle, *Alone Together: Why We Expect More from Technology and Less from Each Other* (Basic Books, 2011).

20. Steven Levy, “(Some) Attention Must Be Paid!” *Newsweek*, March 27, 2006, 16; Anna Quindlen, “Doing Nothing is Something,” *Newsweek*, May 12, 2002, 76; Eric Weiner, “The End of Offline in Flight? Say It Ain’t So,” National Public Radio, Feb. 12, 2009 <http://www.npr.org/templates/story/story.php?storyId=100558227>.

21. Neil Postman, *Amusing Ourselves to Death* (Penguin Books, 2005); Rebecca Tuhus-Dubrow, “Tube-Tied,” *Technology*, Feb. 1, 2015; Allison Wood, “Please Remove the Boob Tube,” *Newsweek*, Nov. 12, 2007.

driving a car is a marvelous thing to do! For those who care about their driving, the point is not merely transportation but the *relationship* between driver and machine. The car becomes an extension of your coordinated hands and feet, eyes and mind, as you choose braking and shifting points and your line through a curve. It's not only about arriving safely at your destination. It's also about making the journey *interesting*. Otherwise, something else dies.

A Safety Alert for Operators issued by the Federal Aviation Administration on January 4, 2012, encouraged airlines “to promote manual flight operations when appropriate.”²⁷ FAA data suggested that human pilots had become excessively dependent on autopilots. When the computer failed or the aircraft encountered situations not anticipated in the programming, evidently some pilots had forgotten how to fly the plane manually. How ironic that at the very time the public started becoming aware of autonomous cars, the FAA had to urge pilots to maintain their manual flying skills! Technology offers marvelous tools, but it can also introduce an abdication of personal responsibility.²⁸ Do I really *need* a refrigerator that will order a jug of milk for me or software that completes my sentences for me? Where is the boundary between accepting convenience and buying into my own diminishment? Will innovation's ultimate legacy be smart machines and incompetent people?²⁹

Let me give voice to my students who write weekly letters for our Science, Technology, and Society course. Riley B. wrote of a growing awareness³⁰:

I don't get out of my comfort zone, I stay trapped inside my lit up screen. . . . I began to think of the significance of the movie “Wall-E.” In this movie . . . the humans rely on technology for everything. . . . Our society is becoming that. We are becoming a society that wants everything done for us, to the point where we dumb ourselves from adults back down to babies, who have to have everything done and given to us. It's scary to think where we will be in 2100.

Macy S. represents many others who have expressed similar doubts in recent years:

I must admit, I am beginning to challenge some of my own views on technology. . . . Our generation teaches us that technology is the only way of life. It teaches us that our careers are geared around technology. . . . There must be a way to find beauty in the world without my eyes being glued to a screen. . . . What happened to face-to-face personal communication? I

am honestly getting frustrated. . . . I have never craved authentic humanity more in my entire life. . . . There's something so suffocating about having to live under the control of technology. . . . The most freeing times in my life have been when I am out in the wilderness, camping, and have absolutely no connection to the internet or my cell phone. I find myself returning from trips like these and not being on my phone half as much. I also find myself looking around more. . . .

Robert Pirsig, who valued technology but could get along fine without it, concluded, “The way to solve the conflict between human values and technological needs is not to run away from technology. . . . The way to resolve the conflict is to break down the barriers of dualistic thought that prevent a real understanding of what technology is—not an exploitation of nature, but a fusion of nature and the human spirit into a new kind of creation that transcends both.”³¹

Perhaps future congresses will build on the 2016 theme of innovation with themes along the line of *Innovation that Respects the Human Spirit*. Future congresses might discuss such questions as:

- Are convenience and efficiency the ultimate values? Are they effective teachers?
- How can innovations leave space for an authentic humanity of adventure and personal responsibility?
- How can smart machines be prevented from seducing their users into states of infantile dependency?
- As lifestyles change with new technologies, what features of human experience should remain constant?
- Just because we *can* do something, does it follow that we *should*?

Fundamental scientific research finds motivation from values of aesthetics and adventure, “seeking unity in hidden likenesses.”³² Building on that unity, much of technological innovation aims to make life's tasks easier and more convenient. Ease and convenience have their place, but they are not disciplines that develop capable human beings. In his last interview, Richard Feynman noted that sometimes life should be lived on a lower level. After all, he said, “Life is not about traveling on the freeway and staying at the Holiday Inn. The whole point is to have adventure.”³³ ●

Acknowledgments

Thanks to the organizers and SPS/ΣΠΣ staff for a superb and significant 2016 Congress and for inviting me to write a reflective article about it. Thanks to Kerry Kidwell-Slak and other editors for useful suggestions, and Glen Dikes for sharing his knowledge of Bell Labs. I am looking forward to the 2019 congress.

27. Nicholas Carr, *The Glass Cage: Automation and Us* (W.W. Norton and Co., 2014), 1; National Public Radio All Things Considered, “Hands-Free, Mind-Free: What We Lose Through Automation,” Sept. 29, 2014.

28. Evgeny Morozov, “The Perils of Perfection,” *The New York Times*, March 2, 2013, <http://www.nytimes.com/2013/03/03/opinion/sunday/the-perils-of-perfection.html>.

29. Mark Bauerlein, *The Dumbest Generation: How the Digital Age Stupefies Young Americans and Jeopardizes our Future* (Penguin Books, 2009); Nicholas Carr, *The Shallows: What the Internet is Doing to our Brains* (W.W. Norton and Co., 2011); Dave Schwartz, “Technology and a ‘Generation of Idiots,’” editorial in *Technology*, June 9, 2014.

30. Riley B. and Macy S. are members of the spring 2017 STS class. For more letters see *Dear Professor Dyson*, ref. 22.

31. Pirsig, ref. 1, 290–291.

32. Jacob Bronowski, *Science and Human Values* (Harper & Row, 1965), 13–14.

33. Documentary, “Richard Feynman: Last Journey of a Genius” (BBC Horizon, PBS Nova, 1988).



The Coder Michael Street

Co-founder of Next Software Group and an educator and IT consultant.
Sigma Pi Sigma, Morehouse College, 2010

I feel that in life it is important to dream big and to focus on contributing to society, but when I was coming out of high school, I lacked a clear picture of what kinds of problems I wanted to solve. I wanted to go to MIT as an undergraduate—I was interested in physics and engineering—but I never applied because I didn't think I would get in.

Thankfully, however, my guidance counselor pushed me to attend an interview with a recruiter from Morehouse College, a historically black college (HBCU) in Atlanta, Georgia. They didn't have an engineering program, so I majored in physics. As a student at Morehouse, I developed the personal conviction and self-confidence required to pursue and achieve my dreams, which included finally applying to MIT to obtain a master's degree in building technology.

Following my master's, I went on to complete a PhD in building technology at Georgia Tech where I developed simulation methods to model the impacts of climate change on the design of urban microgrids.

While working on my PhD, I was aware of how niche my field was, so I also dedicated myself to developing a core set of transferable skills that would serve me well beyond the doctoral degree. I quickly realized that the skills I needed to focus my attention on were computer science, software engineering and problem solving, which I had been honing since being an undergraduate physics major.

After completing my dissertation, I founded Black Men Code, a technology brand focused on providing computer science education to underserved and "under inspired" youth, and joined a minority-owned IT services business as the Chief Technology Officer.

I eventually resigned my post as CTO to pursue my own interests because I had lost the ability to engage directly with emerging technology. I sensed that I risked my own future opportunities if I continued serving federal clients in their comfort zone.

Thankfully, my education in physics has always helped the business

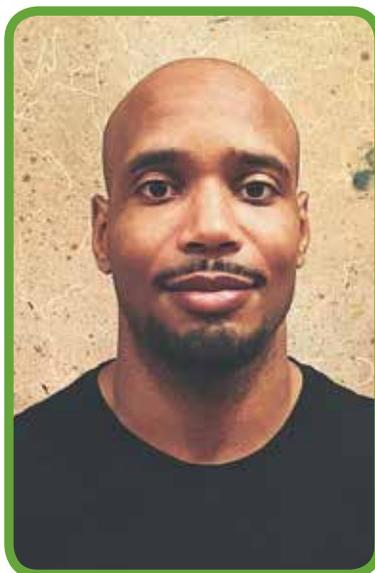


Photo courtesy of Michael Street.

side of entrepreneurship seem logical. Having a physics-based approach helps you think through business questions like, What's the market size for my proposed product? and, How much of that market would we need to capture to break even or see a profit? That's something physicists think about all the time—for example, maybe you're trying to predict the wavelength of an invisible particle and you have to think through how you would detect it.

My newest venture is co-founding Next Software Group, a software development firm that focuses on blockchain technology. Blockchain technologies are tools that rely on decentralized protocols to share data and transfer value. We have two core products. One is called ChainRelay, and it helps other developers build blockchain-based web apps using the Ethereum protocol. The blockchain is a decentralized way to store and share data, including financial data. Our product helps people who, for example, want to monitor when transactions occur

so they can invest in cryptocurrency money markets.

Trading in cryptocurrency like bitcoin in the United States complicates your taxes. If you buy securities through a bank, they are required by law to provide you tax information, but if you buy bitcoin, there's no centralized organization to provide this. Enter our second product, Cryptotax.tools, which lets cryptocurrency traders and tax professionals easily generate reports come tax time.

A physics education at Morehouse College was one of the most important decisions I've made in life. Now I'm focused on building products people want with Next Software Group and giving back through teaching. I recently had the opportunity to work at Morgan State University as a guest lecturer for the first blockchain development class at an HBCU. I helped students design, prototype, and pitch new blockchain products. It's crucial to give back and inspire others to achieve impossible dreams and avoid stagnation. In today's fast-paced, technology-driven economy, stagnation is the surest way to be left behind. ●



The CEO

Alex Kubicek

Co-founder and CEO of Understory, a weather measurement and monitoring service.



Understory field engineer Jonathan Mikolaiczuk tests one of the company's automatic weather stations. The silver ball at the top houses most of the sensors for all types of weather measurements including hail, rain, temperature and wind.



Andrew Piotrkowski of Understory sets up the Madison startup's weather-data monitor on the roof of the 316 Building, 316 W. Washington Ave., Madison, Wisconsin. All photos by Alex Kubicek



In August 2005, I watched on TV as Hurricane Katrina devastated southern Louisiana. Six months later I was on a bus to New Orleans with about 50 of my classmates from the University of Wisconsin to help in the relief effort. For the next week, fellow students and I tore out moldy plaster in an attempt to save the underlying structure of homes from being bulldozed.

I was shocked and saddened by the devastation around me, but I was also hit hard by the implications of us understanding weather so poorly that we could barely provide meaningful assistance to those in harm's way. We were in an age of incredible technological advancement, but we still couldn't understand rain and storms.

After that, I threw myself into the study of cloud microphysics and atmospheric science, with the goal of improving short-term storm forecasting. It was during those studies that I realized there was a massive observation gap in the storm data collected to date. Our radars and satellites had been looking only up at the sky, not measuring what was happening on the ground. This insight inspired me to try to capture on-the-ground weather data. It was this pursuit that led to me cofounding Understory to advance how we, as a society, collect weather data and to attempt to tackle the effects of weather on the world's economy and, most importantly, on human life.

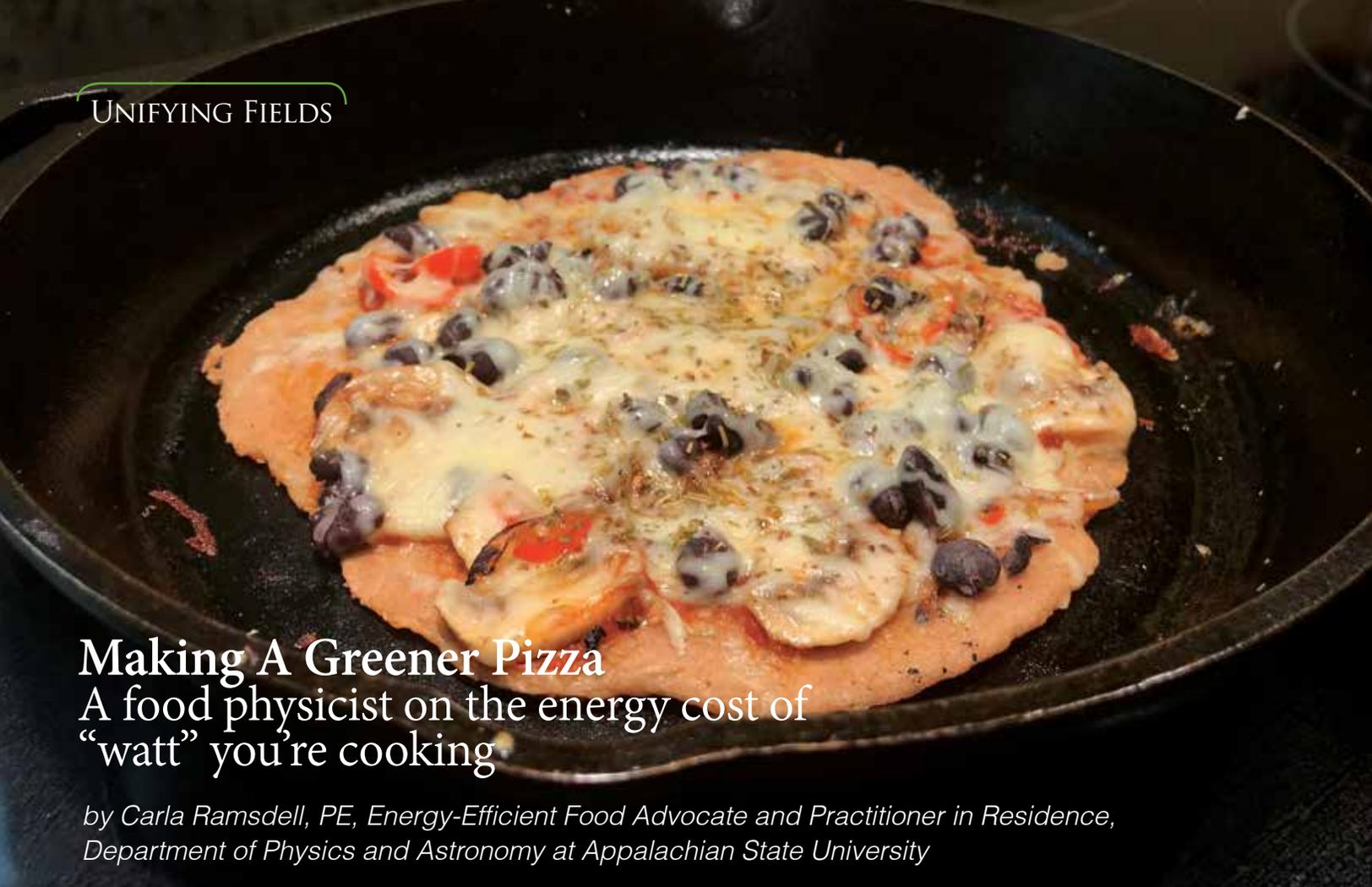
We design, manufacture, deploy, and operate networks of ground-based weather and air-quality sensors that deliver real-time measurements on three continents. These networks have already reduced fraud in the insurance industry and increased efficiency in agricultural supply chains across the globe. And this is just the beginning.

While we've had the good fortune to be successful so far, our progression as a company hasn't been without setbacks—such as our first deployment.

Given that cell towers were already quite prevalent throughout metropolitan regions, we thought it would be fiscally and environmentally smart to use cell towers as installation sites for our weather sensors. So, for our first deployment we scoped out a great location, contracted the required third-party professional installer, and set up our first station. Then, when we flipped on the power switch, nothing happened! The reason sank in immediately: The device was dead on arrival, and we had no way to retrieve it to troubleshoot the issue.

Although this was incredibly problematic for our first deployment, it was a failure that would significantly shape how we approached every deployment thereafter for the better. Learning this bigger lesson—that failures can be just as beneficial as successes—has continued to shape how we approach our products and sales and has really allowed us to thrive as a startup organization.

We'll continue to learn from our failures and build on our successes to help industry partners and cities better understand how they can use our granular weather data in their decision-making processes to improve the lives of people in their communities. ●



Making A Greener Pizza

A food physicist on the energy cost of “watt” you’re cooking

by Carla Ramsdell, PE, Energy-Efficient Food Advocate and Practitioner in Residence, Department of Physics and Astronomy at Appalachian State University

When I tell someone that I study the physics of food, they usually respond with a tilt of the head and the question, What does physics have to do with food?

Well, nothing says “Friday night” better than a warm, bubbly pizza, so let’s consider the options for a home-cooked pizza from a physics perspective to see how physics connects to our food system.

You might guess that eating a pizza made with homemade crust and fresh ingredients has less negative environmental impact than a frozen pizza. That’s true, as there is a dramatic reduction in the processing, packaging, refrigeration, and transportation energy, but that’s not where the discussion ends.

There are different energy costs associated with how the pizza is cooked—gas, electric, convection, or solar oven, for example. But what about skipping the oven completely? Heating an entire oven and its approximately 30 pounds of steel for one pizza isn’t the most energy-efficient option.

College students in my physics of energy-efficient cooking class enjoy performing a hands-on experiment comparing the energy of cooking oven-baked and range-top skillet pizzas. The oven method uses more than four times the energy of the range-top method.

The amount of energy it takes to make a skillet pizza varies with the skillet you choose. My most recent research uses infrared thermography to compare the thermodynamic properties of eight different skillet materials. It turns out that cast iron is an excellent choice for cooking a low-energy pizza. Cast iron’s relatively low thermal conductivity allows the energy from the burner to stay at the bottom of the skillet, close to the food, and its

high thermal mass allows for cooking to continue after the burner is off.

You can further reduce your environmental impact by considering your toppings. Pound for pound, beef is responsible for ten times more greenhouse gas emissions than a vegetable protein counterpart. My favorite toppings are caramelized onions, mushrooms, and black beans.

The bottom line: We have an enormous opportunity to reduce the energy costs and greenhouse gas emissions associated with our food. A sustainable food future requires that we think critically about our cooking and regain control of our food system. Doing so also improves our health and budgets, and gathering around a home-cooked meal is a fantastic way to improve your relationships with family and neighbors!

Here are two simple ways to get started:

1. Shop smart. When you have a recipe that calls for diced potatoes, skip the freezer section and grab them from the produce section or farmer’s market. In doing so, you’re reconnecting to the food system and becoming part of the sustainable food future.
2. Cook smart. Your kitchen is a science lab. Don’t be afraid to experiment with food preparation strategies. Did you know you can cook pasta passively? Simply turn off the burner after the water/pasta mixture comes to a boil and let the water complete the cooking as it slowly cools.

The physics of food is a rich field of study with fascinating, delicious, and practical applications. If you’d like learn more, check out my website at <http://www.knowwattscooking.com>. Happy cooking! ●



Skillet Pizza

by Carla Ramsdell, *Know Watts Cooking*

This is for an 8-inch pizza cooked in a 10-inch cast-iron skillet.

1. Bring skillet to medium heat.
- 2a. Sauté desired veggie toppings, such as onions, mushrooms, and black beans, on a cast-iron skillet. Remove the toppings and set aside, then wipe out any remaining scraps.
- 2b. While the veggies cook, make the dough (or make it earlier and let it rise for an hour before rolling out):
 - Dissolve $\frac{1}{2}$ teaspoon of yeast in $\frac{1}{4}$ cup of lukewarm water.
 - Add $\frac{1}{2}$ teaspoon salt and $\frac{2}{3}$ cup flour.
 - Turn out onto floured surface and knead dough until it stays together, adding more flour as necessary to avoid stickiness.
 - Roll or press into an 8-inch round.
3. Heat the cast-iron skillet to medium high and coat it with a thin layer of canola oil.
4. Place the 8-inch dough round on the skillet and turn the burner down to medium low. Let the dough cook for a couple of minutes.
5. Spray the top (uncooked) side of the dough with oil and flip the dough over so the uncooked side is on the bottom.
6. Quickly top with sauce, veggies, and cheese.
7. Put a lid on the skillet, turn the burner off, and cook for 2–3 more minutes to allow the bottom to cook and the cheese to melt.
8. Remove from skillet, cut, and enjoy! ●

LEFT: A skillet pizza. Hungry yet? Photo by Carla Ramsdell.

TOP: Ramsdell hosts a cooking demonstration in a physics of energy and sustainability class. Photo courtesy of Marie Freeman, university photographer, Appalachian State University.

Reenergizing Sigma Pi Sigma: A Call to Action

by Vanessa Chambers, AZC Zone 15 & SPS Member, Utah State University



What is Sigma Pi Sigma? What does it represent? What can it do for you?

In 1921, five undergraduates and four faculty members at Davidson College officially formed the very first chapter of Sigma Pi Sigma, an organization to recognize outstanding scholarship in physics. This organization acquired membership in the Association of College Honor Societies in 1945 and eventually became affiliated

with the American Institute of Physics. Since the inception of that first chapter, numbers have grown continuously. There are currently 580 chapters across the globe, with the majority in the United States. With our growth and approaching centennial, the SPS & Sigma Pi Sigma National Council felt it was time to take stock of our membership and think about our priorities. Thus, the National Council Sigma Pi Sigma Committee was formed from three student associate zone councilors, three faculty zone councilors, the Sigma Pi Sigma president, and a staff liaison. Our charge is to tackle some of these questions and help provide some guidance for the future. But to do this effectively, we're going to need your assistance!

As members of Sigma Pi Sigma, what role has your membership played in your life? When was the last time you communicated with other members, your home chapter, or a chapter at a nearby university? If you have a meaningful response to these questions, then we applaud you! If you have not had contact with your home or local chapter but would like to, the Sigma Pi Sigma Committee is here to help. We are working to create pathways that will facilitate renewed and greater ties within our community.

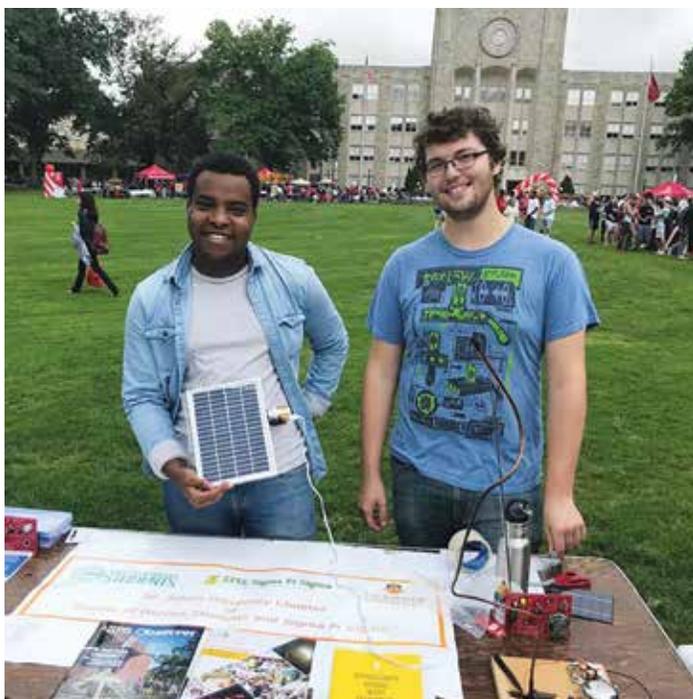
We are truly interested in the benefits that membership in Sigma Pi Sigma has provided for you in the past and what benefits you would like to see in the future.

One important step toward providing a better, more fulfilling experience is the new Alumni Engagement Program (<http://www.spsnational.org/programs/alumni-engagement>). This program provides opportunities for SPS and Sigma Pi Sigma members to communicate with alumni who want to give back, as well as encourage alumni to engage with their home chapter or chapters in their area. There are several ways alumni can participate: speaking engagements, internship opportunities, job shadowing, and more. Your participation in this program is encouraged, and you can visit <http://spsnational.org/connect> to get started.

This committee and the SPS National Council would also like to hear from you! Inside this issue of *Radiations* you will find a survey card with a link to our engagement survey. You can also visit <http://tinyurl.com/sigmapisigma19>. As you consider your responses, please think about what could be done to improve Sigma Pi Sigma as an organization, particularly after induction. What benefits would have been useful directly after induction, and what benefits might be useful as you move into a career and beyond?

Sigma Pi Sigma was conceived to create community among those with a genuine dedication to physics. While it maintains its status as a way to honor academic excellence in the field, there are certainly latent opportunities to promote a greater sense of engagement and value for both existing and future members. Please take a few minutes to complete the short survey and provide insights on how to best achieve this goal and help Sigma Pi Sigma serve its members better than ever.

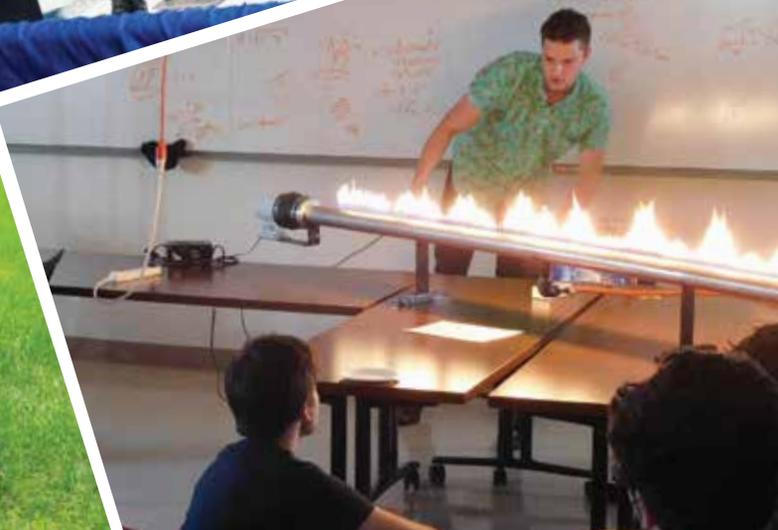
This is the legacy of Sigma Pi Sigma and your legacy. Please help us kick off our next century with a renewed sense of what it means to be Sigma Pi Sigma—a place where members can share expertise, take pride in their achievements, and find a sense of belonging within a supportive community. ●



St. John's University SPS and Sigma Pi Sigma chapters recruiting new members. Photo courtesy: St. John's University SPS.

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Your gifts make possible a broad infrastructure for students in the physics sciences. By supporting our programs, you show your investment in the future. Sigma Pi Sigma and the Society of Physics Students broaden the professional and educational opportunities available for students by providing lifelong learning initiatives, professional development, and a network of supportive colleagues. Thank you for your generosity in 2018.

As we move toward our Centennial Celebration in 2021, we want to recognize that giving is not just about a financial commitment. It's also about making connections and committing time, experience, and wisdom. In the months ahead we will be calling on Sigma Pi Sigma alumni to connect with their alma mater or local chapter to strengthen bonds and form new opportunities. Watch your inbox and future issues of *Radiations* for details.

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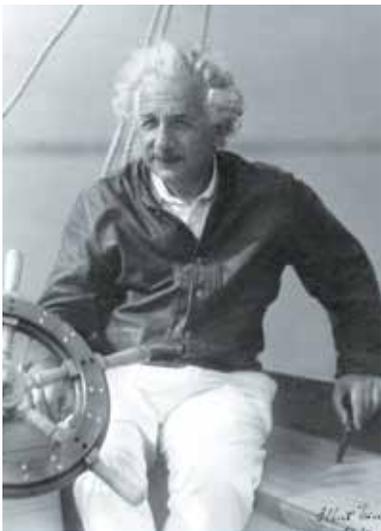
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