the SPS Observer

Volume LIV, Issue 1
SPRING 2021

- Electrifying Young Minds with Outreach
- A Virtual SPS Community Takes Shape
- From LEGOs to Ziploc: The Science of the Snap Fit
- The Many Benefits of Engaging SPS Chapter Alumni
- Lessons on Reading Physics Journal Articles

the SPS Observer

Editor
Kendra Redmond

Managing Editor
Kayla Stephens

Contributing Editors
Korena Di Roma Howley
Brad R. Conrad
Althea Gaffney
Mikayla Cleaver

Copy Editor
Cynthia Freeman

Art Director
Aaron Hansen

Layout Designer
Michael Wernert

SPS President
Alina Gearba-Sell,
US Air Force Academy

SPS Director
Brad R. Conrad

SOCIETY OF PHYSICS STUDENTS

1 Physics Ellipse
College Park, MD 20740
301.209.3007 (tel)
sps@aip.org
www.spsnational.org

Find SPS National on:

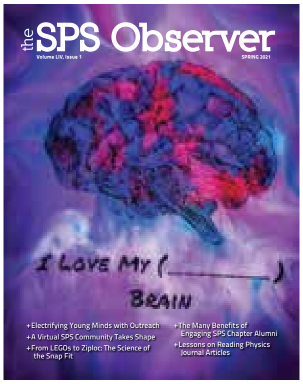
TABLE OF CONTENTS

SPRING 2021 ▪ VOLUME LIV, ISSUE 1

FEATURES

SPECIAL FEATURES

DEPARTMENTS



ON THE COVER
Artwork from the Love Your Brain event at Notre Dame University. Photo courtesy of the Notre Dame SPS chapter.

The ***SPS Observer*** (ISSN 2160-1305) is the magazine of the Society of Physics Students, published quarterly by the American Institute of Physics, printed in the USA. Standard postage paid at Freeport, OH. POSTMASTER: Send address changes to The SPS Observer, One Physics Ellipse, College Park, MD 20740-3841.

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

AIP Member Societies:
American Association of Physicists in Medicine
American Association of Physics Teachers
American Astronomical Society
American Crystallographic Association
American Meteorological Society
American Physical Society
Acoustical Society of America
AVS: Science & Technology of Materials, Interfaces, and Processing
The Optical Society
The Society of Rheology

Other Member Organizations:
Sigma Pi Sigma physics honor society
Society of Physics Students
Corporate Associates

AIP | American Institute of Physics

Navigating Together

by Alina Gearba-Sell, PhD, President of the Society of Physics Students 2017–21 and Professor, Department of Physics, United States Air Force Academy

When I was asked to write this letter and reflect on my four years of service as president of the Society of Physics Students, I couldn't help but think of the unprecedented times we live in and the words of author Gregory S. Williams: "On the other side of a storm is the strength that comes from having navigated through it. Raise your sail and begin."

The academic community, the lives of our members, both students and faculty, and the lives of those around us have been profoundly and forever impacted by the COVID-19 pandemic. We transitioned to remote learning in the blink of an eye, and one year later, many of us are still learning or teaching remotely. Students everywhere found themselves adjusting to online courses, making sense of virtual labs, and dealing with canceled summer internships and the loss of campus jobs. Others found themselves without the comfort of a physics lounge for late-night quantum homework or the opportunity to walk into a professor's office for help with E&M or advice on graduate school. Other students had to come up with creative ways to access the internet and attend remote courses. Faculty had to become familiar with various online teaching platforms and find innovative ways to keep their students motivated by addressing their individual needs, while at the same time having to keep their own children engaged with virtual learning.

ABOVE: Alina Gearba-Sell. Photo by Kayla Stephens, SPS National.

SPS has had to adapt as well in order to navigate these unexplored waters while staying true to its mission of providing local chapters with resources to build and maintain an inclusive community with a strong sense of belonging. We put together a list of remote learning resources for students and faculty, compiled a collection of COVID-friendly ideas for chapter activities, and started a virtual colloquium series, just to name a few of the new resources. In addition, we hosted our acclaimed SPS summer internship program, albeit virtually, and most importantly, we helped many physics students whose financial situations were negatively impacted by COVID via the SPS Emergency Scholarship program.

Traditionally, at the end of the academic year, many departments recognize the accomplishments of their physics majors by inviting them to join Sigma Pi Sigma, the physics honor society. I encourage you to make this year's induction extra special by recognizing those who have made a difference in your chapter's life with an SPS Outstanding Service Award or a Sigma Pi Sigma Outstanding Service Award. Inviting your alumni or one of us in the SPS National Council to virtually celebrate with you is another way to stay connected with the community.

Finally, as we look forward to brighter days ahead, please mark your calendars. The next Physics Congress will be held in Washington, DC, October 6–8, 2022. Its theme, "100 Years of Momentum," is appropriately chosen to celebrate the centennial of Sigma Pi Sigma. While we had to delay the congress for one year due to the pandemic, we promise that the wait will be worthwhile. The planning committee is putting together an amazing program aimed at engaging and inspiring physics undergraduates for the next 100 years. For details, visit sigmapisigma.org/sigmapisigma/congress/2022.

Until then, stay strong, support each other, and do not hesitate to reach out to the SPS National Council if there is anything we can do to help you thrive in your academic pursuits. //

The Many Benefits of Engaging SPS Chapter Alumni

by Mel Blake, SPS Chapter Advisor and Planetarium Director, University of North Alabama

Tradition. It can mean a lot of things to a lot of people. At its heart it's a way of recognizing that we're all part of a continuum, a flow of history and achievement, with science and culture advancing for the better. It also appeals to our inherent need as human beings to belong to a society. We are, after all, social creatures evolved to work best toward common goals with our peers. We all want our achievements to be remembered and valued. One important way that this can be accomplished in a Society of Physics Students chapter is by connecting with alumni.

SPS alumni are more than just "old timers" who tell stories about the way it was. They're also people who've experienced being students of one of the most challenging university majors. They know the struggles, the stress, and the anxiety about whether it will all be worth it in the end (it will be, by the way). Many SPS chapters spend a lot of time establishing themselves as a resource for students, and those responsible for building and shaping the chapter want to know that the traditions of service and camaraderie don't end with their departure. Engaging alumni in your chapter activities will be rewarding both for the students and the alumni.

Our chapter at the University of North Alabama (UNA) remains in contact with our alumni through several means. The easiest and perhaps most natural is through an active social media presence that keeps members and alumni informed and engaged in projects and initiatives. This can sometimes have surprising benefits. For instance, we recently rebuilt the UNA observatory and posted some photos taken through the telescope. An alumnus on our Facebook feed saw the photos and offered us some H-alpha filters. We weren't asking for anything, but he wanted to be a part of the resurgent observatory.

Another way we engage with alumni is through Sigma Pi Sigma inductions. We almost always choose an alumnus to be the keynote speaker for our induction ceremony, and we have never been turned down. We've also inducted alumni into our Sigma Pi Sigma chapter; sometimes an alumnus will give a talk and then be inducted. It makes for a special night.

Even if you don't have a Sigma Pi Sigma chapter, maintaining connections with alumni can be of great benefit. Many of our alumni have gone on to work in industry. On several occasions, we've been contacted by alumni because the company they work for is hiring, and they want to know if we have graduating students who might be interested in applying. The first job after graduation is the hardest to get, so these opportunities are great for our students. Even though we only graduate a few physics majors per year, one company employs four of our former students. Companies trust that our program produces quality employees, and they want our graduates. Our alumni help to make that connection.

TOP: Mel Blake. Photo courtesy of UNA.

ABOVE: UNA SPS members, shown here, received a Sigma Pi Sigma Chapter Project Award to host an alumni guest speaker at the chapter's 2020 Sigma Pi Sigma induction. Unfortunately, the event was postponed due to COVID-19. Photo courtesy of the UNA SPS chapter.

ABOVE: SPS chapters engage alumni in a variety of ways. In this photo, Siena College physics students enjoy a Women in Physics dinner. Local female alumni were invited back to talk about their careers and postgraduation journeys. Photo courtesy of the Siena College SPS chapter's 2019–20 chapter report.

The Careers Toolbox developed by SPS[1] also helps us connect current students with alumni. We've introduced students to these career resources at several meetings and found that many are unfamiliar with opportunities to work in nonacademic settings. In the spring of 2020, we were planning to have two of our alumni who work in industry participate in a question-and-answer session during one of our meetings. We had to cancel this event due to the COVID-19 crisis, but we hope to reschedule.

Alumni can be valuable resources for advice, networking, speakers, and sometimes even astronomy equipment! Like you, they share a love of science and want to have a continued role in your chapter's success. It's about continuing to be part of the family formed through the SPS chapter. I encourage you to include alumni engagement in your chapter's lasting traditions. //

References

1. The Careers Toolbox is a set of tools and exercises designed to help undergraduate physics students prepare to enter the workforce. For details and to explore the toolbox, visit www.spsnational.org/sites/all/careerstoolbox/.

CONNECT WITH SPS ALUMNI FROM OTHER INSTITUTIONS

To connect with physics alumni more broadly, check out the SPS Alumni Engagement Program. You can browse a database of SPS alumni to find potential speakers, tour guides, job-shadowing hosts, and mentors at spsnational.org/programs/alumni-engagement.

BEHIND-THE-SCENES AT LOCKHEED LOCKHEED MARTIN

With alumni as their guide, several members of McMurry University's physics and astronomy department toured the Lockheed Martin Aeronautics Company plant in Fort Worth, Texas, last year. The group visited production lines for F-35 jet fighter planes, which the company makes for a dozen different countries. No photographs were allowed during the tour; shown is a group photo of McMurry's SPS chapter from around the same time. Photo courtesy of Tikhon V. Bykov.

Amanda Sharrow

BS and MS in Physics, The University of Southern Mississippi

What she does

As Amanda Sharrow tells her students, she's "the only show in town" if you need to take physics at the Harrison County (HC) campus of Mississippi Gulf Coast Community College (MGCCC). Being the sole physics instructor on campus doesn't mean she works in isolation, just that Sharrow's colleagues teach other sciences, such as anatomy, biology, chemistry, and kinesiology. "It's fun to see those other sides of science," she says. The water cooler talk can also be entertaining: "What do we have in the fridge today? Cats or brains or what?"

Sharrow teaches calculus-based physics, algebra-based physics, and some sections of a physical sciences lab class. Most of her physics students are engineering or health-related majors that go on to complete four-year degrees at state schools. Some have also gone on to medical school.

Sharrow's job is all about teaching, and she wouldn't have it any other way. Although she's the only physics instructor at the HC campus, MGCCC has two other physics instructors that Sharrow collaborates with on planning, identifying learning outcomes, and assessments.

How she got there

"In high school I had the best physics instructor ever, Scott Pfaff. I loved the problem-solving in the class, and I loved how it was something that challenged me and interested me," Sharrow says. "His teaching honestly changed my life, and it's why I took the route that I did." Pfaff made it a point to show students that physics is a community, not just a subject. When a group of students from the University of Southern Mississippi (USM) SPS chapter came to visit her physics class, Sharrow was thrilled to see people like her succeeding as physics majors. Just a few years later, she was back visiting her old high school physics class as part of that same SPS chapter.

As an undergraduate at USM, Sharrow developed a passion for sharing physics and took on leadership roles in SPS outreach activities at the local and national level. She stayed on at USM for a master's degree, conducting physics education research and leading general physics lab sections as a teaching assistant. It was during those lab sessions that Sharrow discovered her love of classroom teaching. After graduating she became an adjunct instructor at MGCCC and then a full-time physics instructor. Almost seven years in and a recipient of MGCCC's 2021 Instructor of the Year award for the HC campus, she sums up teaching in three words: "It's so fun!"

Best part of her job

"The best part of my job is being in the classroom and interacting with my students," Sharrow says. She loves to see them learning, realizing that physics doesn't have to be scary, and having fun working together on lab activities. "Seeing the looks on their faces when they understand what's going on or they make a connection to something they've seen in their daily life—it's just awesome."

ABOVE: Amanda Sharrow. Photo by Eisley + Oak.

Advice to physics students

To physics students, Sharrow offers these thoughts:

- Don't compare yourself to other people. Even if you're in the same classes, have the same major, and are applying to the same kinds of jobs, your paths will always be different.
- Trust yourself when you're making decisions. Explore what feels right to you. Being a physics major looks different on everybody. Majoring in physics doesn't mean that you have to fit any kind of mold.
- If you're working toward your education in any capacity right now, you should be proud of yourself. We've been presented with so many different challenges over the last year, and I think it's going to be really cool to look back and say, "I was still working toward my goals in the middle of a worldwide pandemic. I can do anything." //

Fall 2020 Chapter Awards

Congratulations to the following winners of the Fall 2020 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 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.

Calvin University
From Every Nation – Physics Mentoring for All
Willem Hoogendam (Leader)
Jason Smolinski (Advisor)

Illinois State University
ISU Physics Tutoring Program
Brighton Coe (Leader)
Matthew Caplan (Advisor)

University of Central Florida
Amplifying Diverse Perspectives
Riley Havel (Leader)
Costas Efthimiou (Advisor)

University of the Sciences
What's So Hot with Physics?
Dan Fauni (Leader)
Roberto Ramos (Advisor)

The University of Texas at Dallas
Physics HALO
Victoria Catlett (Leader)
Jason Slinker (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.

Cleveland State University
It's Getting Hot in Here!
Andrew Scherer (Leader)
Kiril Streletzky (Advisor)

University of Dayton
The Power of Light: Increasing Interest in Physics Through Optics
John Merkle (Leader)
Jay Mathews (Advisor)

University of Rochester
DIY Physics Demonstration Boxes
Molly Griston (Leader)
Frank Wolfs (Advisor)

University of the Sciences
The Sound of Science
Keeran Ramanathan (Leader)
Roberto Ramos (Advisor)

SIGMA PI SIGMA CHAPTER PROJECT

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

Missouri Southern State University
Facing Forward
Joshua Numata (Leader)
Jency Sundararajan (Advisor)

University of the Sciences
Sigma Pi Sigma: Induction Ceremony
Matthew Becker (Leader)
Roberto Ramos (Advisor)

Wheaton College
Increasing and Supporting Sigma Pi Sigma Honors Inductions
Stephen McKay (Leader)
Heather Whitney (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.

Florida Polytechnic University
Microencapsulated Thermochromic Materials for Energy Savings Applications
Daniil Ivannikov (Leader)
Sesha Srinivasan (Advisor)

Old Dominion University
Observational Astronomy
Alicia Mand (Leader)
Matthew Nerem (Advisor)

Purdue University–West Lafayette
A Rope within a Rope: Fluid Polymerization in the Liquid Rope Coiling Effect
Matthew Schulz (Leader)
Rafael Lang (Advisor)

Rhodes College
Standardization of Novel Photovoltaic Cell Characterization for Rhodes College Cubesat Program, RHOKSAT
Giuliana Hofheins (Leader)
Brent Hoffmeister (Advisor)

South Dakota State University
Ultrathin PTAA Layer and Phenylhydrazinium Iodide for Defect Passivation and Enhanced Charge Carrier Mobility in Perovskite Solar Cell
Abdullah Al Maruf (Leader)
Robert McTaggart (Advisor)

Universidad Autonoma de Ciudad Juarez
Xenon Beam to Detect Polluting Particles
Julio Lopez Ibarra (Leader)
Sergio Flores (Advisor)

University of Central Florida
Simulations of Black Hole Dynamics: From Event Horizon to AMD Ryzen
David Wright (Leader)
Costas Efthimiou (Advisor)

University of North Alabama
Speckle Imaging for Fun and Outreach
Charles Harville (Leader)
Ronald Blake (Advisor)

Do You Want to Build a (Colossal) Snowman?

by Brad Conrad, Director, SPS and Sigma Pi Sigma

Puzzler: How large of a snowperson could you make?

I'm sure people will use a flurry of different methods to solve this puzzler! This question is an extension of an actual fifth grader's question at an "Ask anything" session during an outreach event in Florida. The student asked, "How big could you build a snowman?" to which I replied, "Well, it depends on how much it snowed!"

BREAKING IT DOWN

While the material science of snow is extremely interesting,[1] I propose we break this problem down into two separate questions:

1. How much snow do we have to work with?
2. If I could collect all that snow, how large of a snowperson could I make?

As with any good back-of-the-envelope calculation, we should also state the assumptions. As we go along, I'll note those in *italics*.

HOW MUCH SNOW DO WE HAVE TO WORK WITH?

This is probably the hardest part of the problem because it involves so many assumptions! If we're going big, I'd collect all the snow from an entire snowstorm. That means I'd first need to estimate the volume of snow produced by the storm. Doing so requires two things: the surface area covered by the storm and the average depth of snow. From growing up at a higher latitude, I would guess an average snowstorm drops four

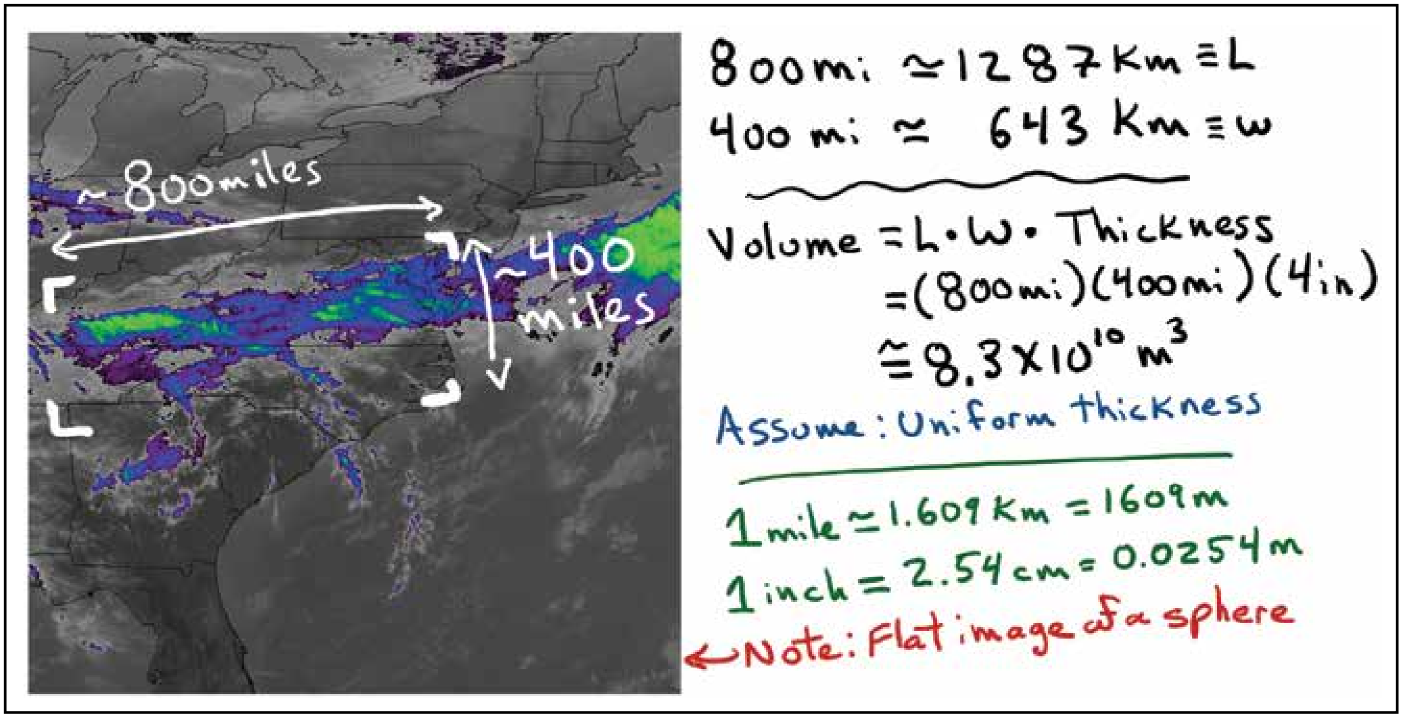


Figure 1. Sketches outlining a calculation for the volume of snow produced by a single storm. For the record, $8.3 \times 10^{10}\ \mathrm{m}^3$ is a lot! Includes a modified weather satellite image, courtesy of the NASA George C. Marshall Space Flight Center, Earth Science Branch, in Huntsville, AL.

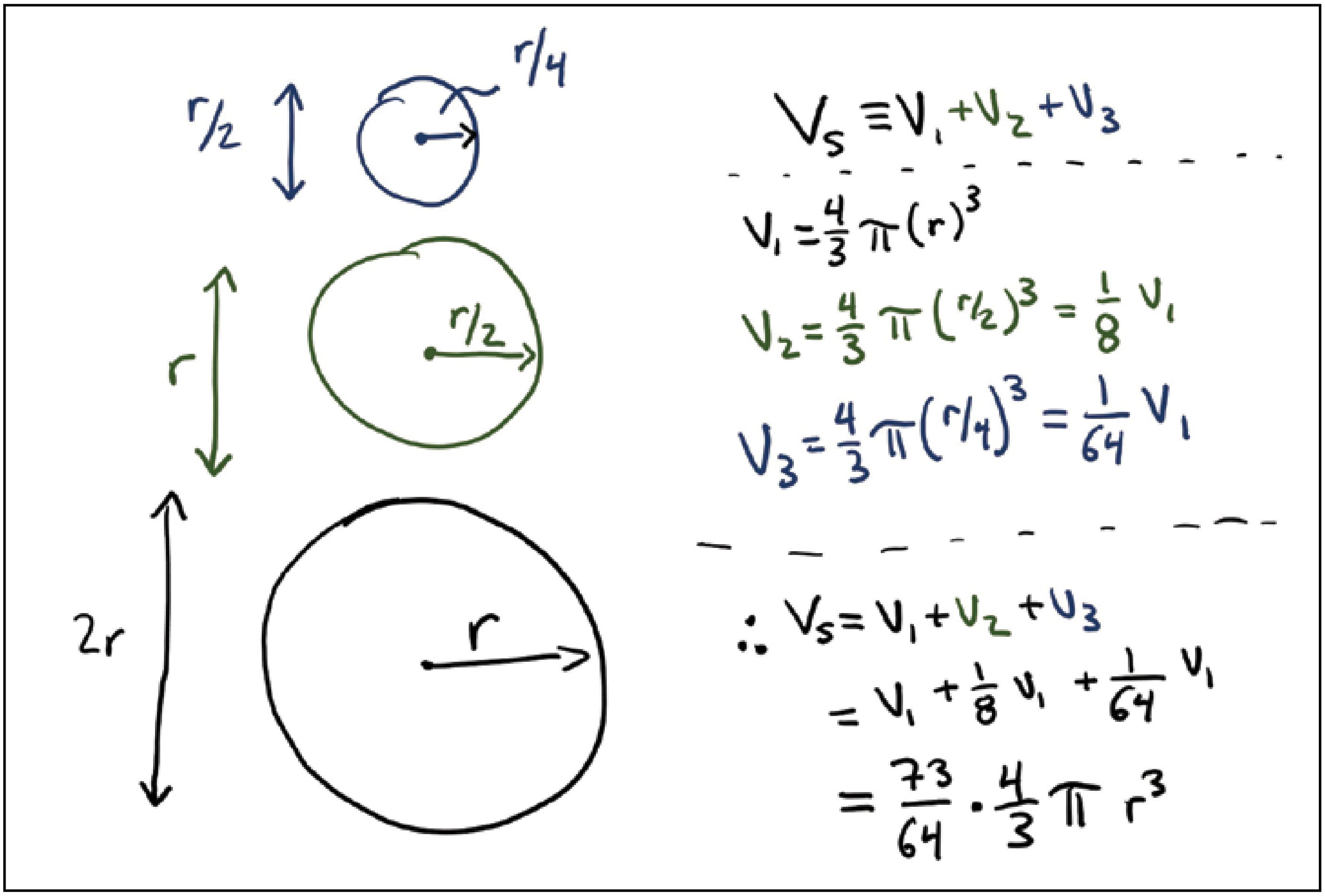


Figure 2. Sketch calculating the volume of a snowperson made of three *perfect spheres*. Since we are solving for the radius, we end up with $\frac{73}{64}\cdot\frac{4}{3}\pi\cdot r^3$ as the total volume. We can see that most of the mass is located in the bottom of the snowperson, and it'll be 3.5 radii tall (with no top hat).

inches of snow and covers a really big area—something like several US states.

But, as anyone who's ever made a snowball knows, snow compacts a lot when compressed.[2] Let's *assume* it compresses to a quarter of its volume (2.1×10^{10} m^3).

WELL, HOW BIG OF A SNOWPERSON CAN WE MAKE WITH THAT MUCH SNOW?

The tallest snowperson on record had more of a cone shape, but let's assume we can engineer a snowperson from three spheres. Let's also *assume* that each sphere is half the diameter of the lower sphere.

We can now pull it all together, since we know the volume of compacted snow V and the volume of the three-sphere snow V_S. By setting them equal to each other and solving for the radius, we get a height of 3.5•1640 m, or about 5.73 km. For comparison, Mount Everest is the tallest mountain in the world at about 8.85 km.

YOUR TURN!

In this calculation, I made a pretty rough *estimate* of how snow compacts. In reality, the snow would compact A LOT, and most of it would become ice through melting,[2] which has a different packing ratio. Also, I assumed a three-sphere snowperson. For comparison, the tallest snowperson ever constructed was about 34 m tall and had a cone shape—which, in terms of mechanics, is a much better design.

If we took these factors into account, what height could we expect? //

References:

1. Henri Bader, *The Physics and Mechanics of Snow as a Material*, Cold Regions Research and Engineering Laboratory, 1962.
2. Angela Herring, "The Physics of a Snowball," *News@Northeastern*, January 2, 2014, https://news.northeastern.edu/2014/01/02/the-physics-of-a-snowball/.
3. "Austria Breaks Record for World's Tallest Snowman," *DW*, February 2, 2020, https://www.dw.com/en/austria-breaks-record-for-worlds-tallest-snowman/a-52229428.

Check out our answer at
spsnational.org/the-sps-observer.

A New Approach to Improving Lithium Anodes in Lithium Metal Batteries

LEFT: Abdullah Al Maruf works with a plasma annealing chamber to create a thin film coating of PLNM on the lithium anode. Photo courtesy of SDSU.

by Abdullah Al Maruf and Ke Chen, SPS Members, South Dakota State University

Almost all modern electronic devices, as well as electric and hybrid vehicles, depend on lithium-ion batteries (LIBs). Despite major industrial efforts to create robust LIBs with high energy density and make them commercially available, their performance and efficiency have not kept pace with consumer demand for energy storage over the past decade. This is a major obstacle in transitioning to a sustainable energy-dependent future.

This past year, our SPS chapter at South Dakota State University (SDSU) used an SPS Chapter Research Award to explore the development of another kind of lithium-based battery, a lithium (Li) metal battery. These batteries use a Li metal anode instead of the more conventional graphite anode of LIBs. Li metal has a high specific capacity of 3860 mAh/g—ten times that of graphite—which means batteries with a higher energy density can potentially be achieved.

We wanted to create a safe, high-energy-density Li metal battery, and to reach this goal we needed to tackle a crucial performance limitation of Li metal anodes—dendrite formation. When Li metal is used as an electrode, needlelike microstructures called dendrites form on the surface of the anode and grow over time during charging cycles. This is a major problem because dendrites can penetrate the separator between the anode and cathode in the battery, causing a short circuit and potentially resulting in combustive electrolytes catching fire. Using Li metal as an anode has other problems as well, such as uncontrolled interfacial reactions and degradation, and large volume changes during Li plating and stripping.

To overcome these limitations, we decided to guide the deposition behavior of the Li metal we used for the anode of our battery. We created a novel glass fiber matrix thin film called partially lithiophilic nonconductive matrix (PLNM) using amorphous silicon dioxide. We then deposited Li metal onto PLNM and studied Li plating and stripping behaviors in cells.

Using a scanning electron microscope (SEM), we compared the postcycling surface morphology of our Li-PLNM anode to a conventional graphite anode surface. Our results show that we were able to successfully suppress dendrite formation and growth on the Li-metal anode. In addition, the battery we created has a higher capacity and power density than what's been reported in peer-reviewed journals for LIBs. Our battery performed especially well in power density, specific capacity, cycling life, and durability (battery stability). We hope that our lithium anode will be a candidate for commercial application.

Throughout this project, the major obstacle was that the lab was shut down for two and half months due to COVID-19. This meant we needed to remake samples and repeat some of the experiments. Interestingly, while our project proposal was mainly focused on experimental laboratory research, during the shutdown we explored some rigorous theoretical approaches to improving performance that we later tested experimentally in the lab. We have now written a manuscript on this work and submitted the paper to a peer-reviewed scientific journal.

This project created new undergraduate research opportunities for physics students at SDSU. Two of our team members are applying to graduate school, and this SPS research experience was particularly helpful to them, as it made a significant impact on their graduate school preparation and their future endeavors in research. This, in turn, has inspired others in the physics department to get involved in physics research.

The research team included Abdullah Al Maruf, Ke Chen, Rajesh Pathak, and Nick Carlson, and we'd like to thank Dr. Yue Zhou, Dr. Qiquan Qiao, and Dr. Robert McTaggart for their guidance. //

For information on the SPS Chapter Research Awards and to apply for funding, visit spsnational.org/awards/chapter-research.

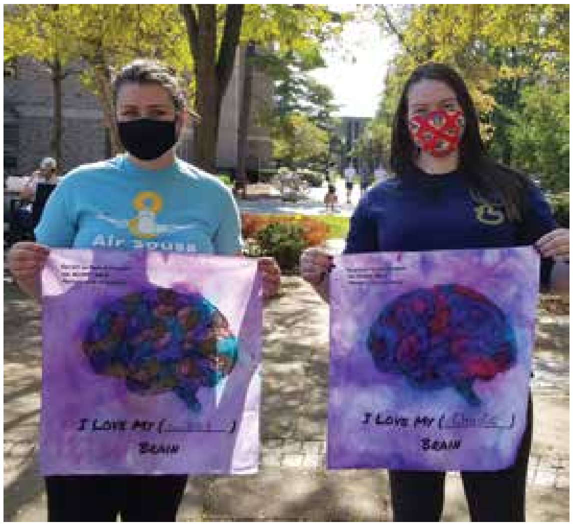
Loving Your **Messy, Beautiful, Complex Brain**

by Lauren Ward, SPS Chapter President, University of Notre Dame

We all need a little help sometimes, whether it comes from a friend lending a helping hand or from having someone to talk to when times are tough. Unfortunately, times always seem to be tough in today's pandemic-ridden world, so it was important for the Society of Physics Students chapter at the University of Notre Dame to remind the student body to be kind to themselves. Part of this effort involved partnering with Access-ABLE—a campus advocacy club for students with disabilities and allies—to raise awareness for people with mental illnesses and traumatic brain injuries through our Love Your Brain event. All it took was a table set up on campus, some bandanas, the most ostentatious Sharpies we could find, and bottles of rubbing alcohol.

Brains are messy and beautiful and complex in ways we still don't fully understand. To mirror this, we printed outlines of the brain on bandanas, colored them in, and used some basic chemistry to add some chaos. Most of us have learned the hard way that running water is no match for a stain made by permanent markers. This is not the case with permanent ink and rubbing alcohol. The permanent marker is absorbed by the rubbing alcohol, and as the alcohol spreads, it carries the ink with it to make beautiful patterns. Students furiously colored in their bandanas and watched as the rubbing alcohol transformed the outlines into messy and beautiful and complex patterns mirroring their own brains.

It was wonderful to see students from all over campus come to celebrate their brains, including a small herd of physics majors who descended on the event in the afternoon. There were laughs and smiles all around as students made art (and a mess), and it gave students a chance to take a minute for self-care and to talk about how their mental health has been impacted by the pandemic.



ABOVE & LEFT: Notre Dame's Love Your Brain event. All photos courtesy of the Notre Dame SPS chapter.

Unfortunately, as of this writing, the pandemic is still in full swing, and because we still need to take time to love ourselves and take care of friends and fellow students who are suffering, SPS and Access-ABLE are currently in the process of planning another Love Your Brain event this spring. //

Revealing the Human Side of Science

by Korena Di Roma Howley, Contributing Editor

In the early 1960s, meteorologist Edward Norton Lorenz observed that his computer simulations of future weather were sensitive to the tiniest changes in the starting value of his equations. This discovery led to chaos theory, and it's one of the most famous stories in computational physics. But it isn't the whole story.

In 2017 scientist Daniel Rothman came across an unfamiliar name in Lorenz's seminal paper on chaos, "Deterministic Nonperiodic Flow," which led him to uncover the contributions of two women who worked as programmers in Lorenz's lab. They are the subjects of science journalist Josh Sokol's *Quanta* magazine piece "The Hidden Heroines of Chaos," for which Sokol received the American Institute of Physics 2020 Science Communication Award for Articles.

In telling the stories of Ellen Fetter and Margaret Hamilton, Sokol lifted yet another curtain on the early work of women mathematicians. He does so, according to award judges, with an "exemplary combination of storytelling and physics explanation."

After hearing from Rothman about his discovery, Sokol knew he had to write about it. "There were these people who had played pioneering roles, and they had been overlooked and not credited in the way they would be in the modern world," he says. He describes the award as "enormously exciting and encouraging," adding that it indicates a high level of engagement with the topic and with the issues of representation that the story addresses.

Sokol began his writing career while working as a research instrument analyst at the Space Telescope Science Institute (STScI) in Baltimore, Maryland. A double major in astronomy and English literature at Swarthmore College, Sokol found that, from the start, he was particularly interested in Hubble's wide-reaching public profile. "I ended up trying to convince the people who did press releases for Hubble to let me write some of them," he said. "That was my first real ability to combine my interests, and it was really exciting."

After two years at STSci, Sokol entered MIT's Graduate Program in Science Writing. He then completed a six-month internship at the UK-based *New Scientist* magazine. Today a freelance journalist, Sokol has contributed to *Science*, the *New York Times*, and the *Atlantic*, among other publications.

One of the most rewarding aspects of his work, he says, is the opportunity to address the human element of science stories. "You can talk about characters, and you can talk about scientists having emotions," he says. "There's freedom to tell the more traditional kinds of human stories and not just report the pure, rigorous scientific investigation."

Still, for anyone interested in a career in science writing, Sokol says that the highly competitive field has its challenges, especially in the day-to-day generation of ideas and the work of selling those ideas to editors. He adds that while salaried writers and institutional communicators may have more stability, they also likely have less freedom to pursue topics that interest them.

"My work is very broad," Sokol says. Though he continues to write about astronomy, he's also covered other disciplines, including paleontology, disease ecology, and conservation.

His advice to aspiring science communicators: hone your writing skills. "They will serve you if you become a science writer, and they'll serve you in your career," he says. "It's good

ABOVE: Josh Sokol. Photo courtesy of Josh Sokol.

to just practice explanatory writing and writing that gets people to care about an obscure subject."

It's also important, Sokol says, to find opportunities to write within an institution or department. "Work with the people who are doing the outreach communication and test out if you enjoy it and get them to give you feedback," he says. "Because if you can do writing with a well-defined purpose and get feedback on it, that's the way that you'll improve and get to test your limits." For those who then want to go further, he suggests seeking out programs such as the AAAS Mass Media Science and Engineering Fellowship or considering a master's program in science communication.

It also helps to love science, Sokol says. "I'm constantly thrilled that I get to learn about something cool every day." //

To read Sokol's award-winning article "The Hidden Heroines of Chaos," visit *Quanta* magazine at quantamagazine.org/hidden-heroines-of-chaos-ellen-fetter-and-margaret-hamilton-20190520/.

SPS OUTSTANDING SERVICE AWARD

SPS awards faculty and students who exemplify an attitude of service to the discipline of physics and astronomy through actions at the local, national, or international level.

Do you know an SPS or Sigma Pi Sigma member that has had a positive impact on an SPS chapter, a department, or the broader community?

Nominate a member today!

www.spsnational.org/awards/service

Applications are accepted on a rolling basis.

ΣΠΣ OUTSTANDING SERVICE AWARDS

ΣΠΣ is looking to award individuals who have performed meritorious service to the field of physics, to Sigma Pi Sigma, or to your department.

Awards can be bestowed by individual chapters.

Nominate someone today!

www.sigmapisigma.org/awards/service

Recipients receive national recognition and certificate.

FEATURE

FACES OF PHYSICS:

Campus Event Turned Virtual Speaker Series

by Kendra Redmond, Editor

Marshall University's SPS chapter had well-laid plans for their 2020 Future Faces of Physics Award. Rooms were reserved and details were coming together for a campus visit, colloquium talk, and public talk by Natalia Lewandowska, a pulsar researcher then at West Virginia University, now at Haverford College. The goals of these activities were simple: promote astrophysics in the Appalachians, where Marshall is located, demonstrate that there is work for scientists—including female scientists—in West Virginia, and highlight the benefits of equal gender representation in physics.

Then COVID-19 hit the United States, and the April event was put on hold until the fall. When it became clear that a safe in-person event wouldn't be possible in the fall either, Marshall's SPS chapter leaders decided it was time to go virtual and go big.

"Since we still had resources granted to us by the Future Faces of Physics Award, we decided to expand our plans from one speaker to several," explains Ellie White, the project co-organizer and SPS chapter vice president. "Groups like Black in Astro and ShutDownSTEM have done amazing work this year to bring much-needed discussions about equity and inclusivity to physics and STEM fields, and we wanted to support those goals." To this end, the chapter put together a virtual Faces of Physics speaker series with a lineup of amazing physics and astronomy researchers from groups traditionally underrepresented in the field. With the Future Faces of Physics Award money, they were able to offer an honorarium to each speaker.

The series kicked off in November of 2020 with a livestream of Lewandowska's talk, "The Case of the Perfect Clocks in the Sky," followed by a live question-and-answer session. This successful event was followed by six more talks during the winter and spring, featuring topics ranging from the physics of cancer to the search for intelligent life near the galactic center. All of the talks were free and advertised on campus and to the public.

Transitioning from a single in-person event to a virtual speaker series was "an interesting experience," White says, and one that paid off. "[O]ne of the greatest challenges with organizing the speaker series was the same challenge many of us have when organizing on-campus events—how do you attract an audience to come learn about physics, especially in this day and age with virtual events when everyone is 'Zoomed out,' so to speak?," she explains. "A silver lining of having a virtual speaker series, though, is that even if people don't catch the talks live, the recordings are on YouTube, and we've seen many instances where even if we had just 10 or 20 viewers on the livestream, the recordings will end up with hundreds of views—and this is a much bigger footprint than we could have hoped to make with in-person talks on Marshall's campus."

The Faces of Physics speaker series is the chapter's largest community outreach program in recent history. "[The students] heard from some amazing presenters and learned about some fantastic physics projects along the way, all while getting the on-campus and off-campus communities involved," says Marshall SPS advisor Sean McBride. "The skills they have learned, from setting up the meetings to working in a team environment, combined with some of the inspirational messages in the talks, will all stay with them long after they leave Marshall."

A highlight of the experience for White has been interacting with "so many amazing, brilliant scientists" at different stages in their careers. "Each lecture has been unique, and I've learned so much through the course of this series, both from the speakers and from the process of organizing it," she says. "As a club we have been incredibly lucky that these scientists have been willing to give of their time and share their expertise."

GET MORE INFO

To view the Faces of Physics speaker lineup and get links to the talks on YouTube, visit marshall.edu/physics/society-physics-students.

For information on the SPS Future Faces of Physics Award and to apply for funding, visit spsnational.org/awards/future-faces.

To chapters interested in hosting speakers, Marshall chapter president Jacquelyn Sizemore offers this advice: “Be intentional with who your club invites. You of course want to have someone who is accomplished in their field, but . . . Is this someone you think has an exciting story to tell? Is this someone you or others may not have heard from otherwise? Is their work relevant to you, your club, department, school, or community?” And, she says, "if you’re hosting a virtual talk, be sure to have a test run well in advance!" //

RIGHT: A flyer highlighting talks in Marshall University’s Faces of Physics speaker series. Image by Marshall University’s SPS chapter.

BELOW: Members of Marshall University’s SPS chapter on a 2019 trip to Green Bank Observatory (L-R): Maria Ibarcena Woll, Jackie Sizemore, Jon Keaton, Luke Foster (guest), Dr. Sean McBride, Jeremy McCloud, Andy Prostor, and Ellie White. Photo courtesy of the chapter.

FEATURE

ELECTRIFYING Young Minds with Outreach

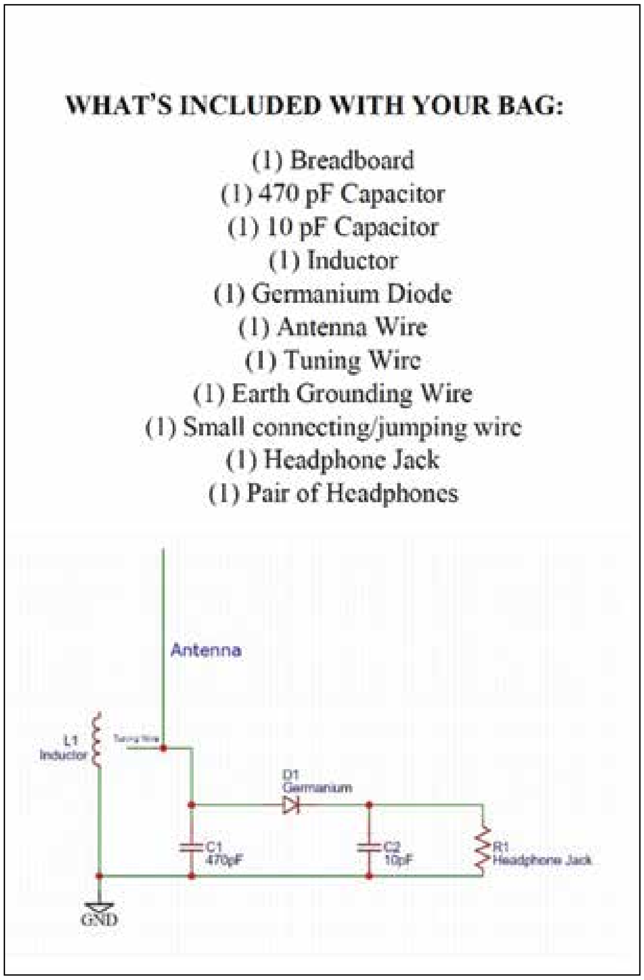
by Dr. Rhett Herman,
SPS Advisor,
Radford University

The Radford University SPS chapter received an SPS Marsh White Award in support of "Electrifying Electronics," an outreach event for guiding students through building an unpowered radio. Unfortunately, we had to postpone our plans when Radford University and Radford, Virginia, public schools went virtual due to COVID-19.

When Radford University resumed in-person classes in fall 2020, we held the event with a bit of a twist on the original concept. Instead of an in-person make-and-take event, we delivered experiment materials to students in preparation for a Zoom workshop. Our SPS members collected the materials in paper bags (which can be recycled!) and delivered them to Radford High School for students to pick up when they attended in-person class. We provided everything that they needed to build their radios, including an inductor coil made by our SPS students.

To host the Zoom event, five Radford SPS members and I gathered in a large lab on campus that permitted social distancing. We were joined online by Shannon Wolford, the physics teacher at Radford High School, and 19 students, who were connecting from their own homes.

The workshop began with our SPS students describing the physics behind radio reception and AM signals. The high school participants were then sent to one of four breakout rooms, each led by an SPS member. The SPS students had their own circuit bags ready and built their radios alongside the outreach participants. As advisor, I floated between breakout room groups to help with any questions.



WHAT'S INCLUDED WITH YOUR BAG:

(1) Breadboard
(1) 470 pF Capacitor
(1) 10 pF Capacitor
(1) Inductor
(1) Germanium Diode
(1) Antenna Wire
(1) Tuning Wire
(1) Earth Grounding Wire
(1) Small connecting/jumping wire
(1) Headphone Jack
(1) Pair of Headphones

TOP: Radford SPS members lead breakout rooms for event participants.

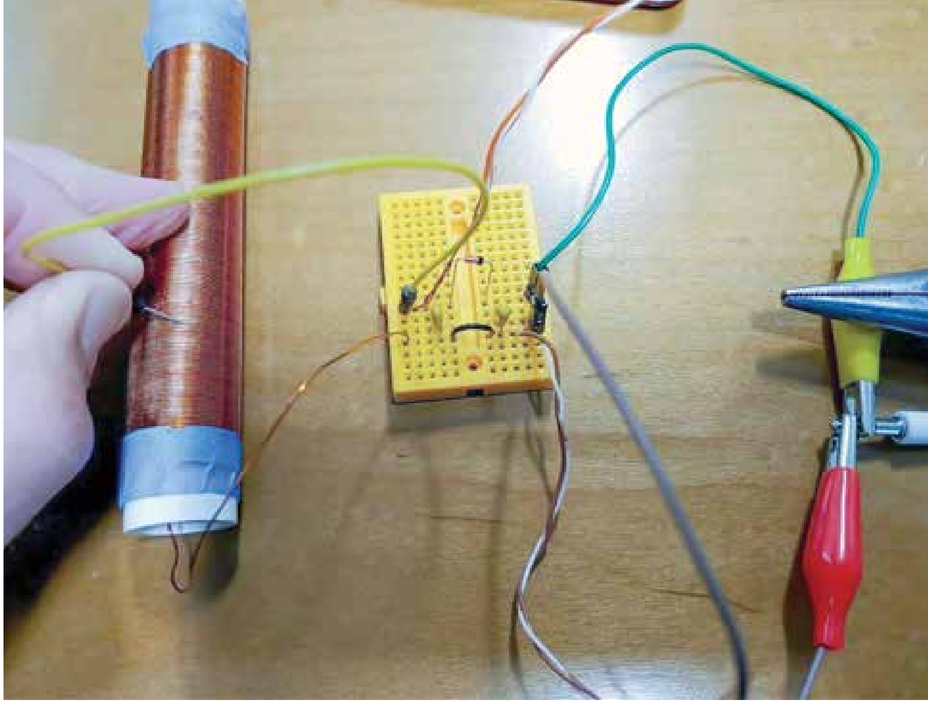
ABOVE: Image of the paper stapled to each bag, listing parts and showing the circuit diagram for the unpowered radio.

Ironically, holding the event on an exceptionally clear fall afternoon made for poor experimental conditions. Clear weather is notoriously bad for AM radio propagation, and the afternoon is a particularly poor time for AM radio reception. Some of us of a certain age recall being able to pick up AM radio stations from far across the country at night and in times of bad, stormy weather. During the event, Wolford and I shared anecdotes of listening to WLS in Chicago from our childhood homes in Virginia and North Carolina, respectively—clearly, but only at night!

In the end, only one of the high school participants was able to hear a radio station during the event, as no one was in a sufficiently quiet location. Most participants were outside on this beautiful, clear day, which had a steady, moderate breeze. There were also near-constant industrial and road noises, even in our small mountain community. Our SPS members managed to pick up two distinct stations, but only after going into my office and closing the door. We told participants that they would have better luck hearing a radio station at night, when it's quiet, and that their reception would be influenced by the weather. We also shared that solar activity would influence their reception, a comment that piqued the interest of more than a few students.

We learned a number of lessons from this initial event. Even though SPS members were at least 10 feet apart in a large room, talking all at once over Zoom led to a lot of cross-noise. For future events, the leaders of the breakout rooms will be in separate locations. Also, including a set of slides would help with explaining the basics of radio transmission and reception and would enable visuals for how to build the circuit from start to finish.

The Radford SPS students were excited to share their enthusiasm for physics with the community, and an SPS Marsh White Award provided the perfect opportunity to do so. We plan to repeat this event in the spring, as COVID restrictions permit. //



TOP: A working radio setup. A germanium (Ge) diode spans the "trough" that runs down the middle of the breadboard circuit and two capacitors on either side of the diode. An inductor tuning coil is on the left. The yellow wire runs from the Ge diode to the tuning coil; sliding it along the coil changes the received station. The breadboard-to-alligator clips (green and brown wires) are clipped to 2/3 connections of the audio jack attached to earbuds. The antenna and the ground are the orange-and-white and brown-and-white wires, respectively.

ABOVE: SPS president Sam Williams with 25 bags of experimental materials for the workshop. All images courtesy of Radford University's SPS Marsh White Report.

FEATURE

A VIRTUAL SPS Community Takes Shape

by Robin H. Glefke,
SPS Member,
Georgia Institute of Technology

ABOVE: Robin Glefke. Photo courtesy of the author.

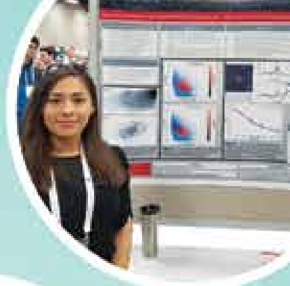
Spring is the busy season for Georgia Tech's Society of Physics Students chapter, and last year activities were in full swing as the semester began. Typically, most of our big events—a formal, a high school physics competition, a department cookout, and many outreach events for children—are held from March to May. But as we all know, in March 2020 the world entered a crazy tailspin that resulted in the cancellation of these in-person activities. We were devastated by the loss of our efforts and stressed by the state of the world. Ultimately, however, it's not the activities we do that make our chapter great—it's the community of people within it who lift each other up.

In those final months of the 2019–20 school year, we rallied. We sent out a survey shortly after the lockdown started to check in on our members and ensure they were financially stable, safe, and happy. While most students were doing okay, many were lonely and bored. Thus began our efforts to translate chapter activities to a virtual platform. By a grand stroke of luck, we had transferred nearly all of our communications to Discord the year before, so we were able to use the platform to host movie nights and public speakers—and to just keep in touch. Our Public Relations Committee even organized a virtual debate between professors Ignacio Taboada and Nepomuk Otte on the existence of dark matter and dark energy for more than 35 attendees.

We also rebooted our Excellent Adventures series, where we invite students to give technical talks on things that interest them. We had a talk on Mathematica from Arben Kalziqi, an alumnus who now works for the company, as well as talks on the fundamentals of the word processing language LaTeX and the applications of split-complex numbers to physics. Alumna Mathilda Avirett-Mackenzie suggested hosting an online coffee hour to help SPS members stay connected, and the first of these was such a success that we made it a weekly event.

Time passed, and soon it was fall, but we were still quarantined in our dorms and homes across the globe. We considered how we could connect with first-year physics majors in this environment and decided on mentor-mentee bingo. Each student interested in being a mentor or mentee posted a blurb about themselves in Discord, and people were matched based on their interests. The pairs then participated in virtual activities to cross off squares on a bingo card. Squares included activities such as homework assistance, a discussion about registering for classes, and attending a movie night. The pair with the most squares completed at the end of the semester received a prize. The program was a huge hit! During the fall we also livestreamed a pumpkin drop on Twitch, and the money raised from pumpkin sales funded the club's newly christened Minecraft server, where members blow off a little steam amidst the chaos of classes and the world.

Despite the pandemic, we are still here for each other. Our new chapter found ways to connect and realized that a virtual SPS chapter can still be pretty awesome. After all, you can't set your background to a Baby Yoda meme when you meet in person! //



SPS Chapter Report

Submission Deadline: June 15

Importance of Chapter Reports

- Share your efforts and best practices with other SPS chapters
- Update your chapter contact and leadership information
- Provide guidance for future SPS members in your chapter
- Determine your chapter's strengths and areas for improvement
- Receive feedback and recognition from SPS National

Qualify for National Recognition

- SPS Outstanding Chapter Awards
- Blake Lilly Prize
- Feature in SPS publications, such as the *SPS Observer* or *Radiations*.

For more information on chapter reports, visit **www.spsnational.org/chapter-reports.**

Has your leadership changed since your last chapter report? Update your contact information with the National Office anytime at **www.spsnational.org/chaptercontacts.**

AIP American Institute of Physics

The Society of Physics Students

One Physics Ellipse, College Park, MD 20740 | Tel: 301-209-3007 | Email: sps@aip.org

Find us @SPSNational:

SPS

SPECIAL FEATURE

Rush Holt on Bridging the Worlds of Science and Public Policy

Interview by Gia Jadick, SPS Mather Public Policy Intern 2019

TOP: Gia Jadick. Photo courtesy of SPS National.

ABOVE: Rush Holt, former congressional representative. Photo courtesy of Wikimedia Commons. Public Domain.

On behalf of the *SPS Observer*, 2019 SPS intern Gia Jadick sat down (virtually) with former congressional representative Rush Holt to get his take on the intersection between science and public policy. Holt is a PhD physicist who served as the US representative for New Jersey's 12th congressional district from 1999 to 2015 and is CEO emeritus of the American Association for the Advancement of Science (AAAS). Responses have been edited for length and clarity.

Can you share some of your unique background and philosophy?

From my earliest memory, I've been interested in how things work—that's science—and how people get along—that's politics. Both of my parents were like this as well. My mother was first a biology teacher, then later a state legislator and secretary of state in West Virginia. She was the first woman in statewide office in West Virginia. I realized you could combine science and politics, and there was nothing wrong with it.

While an undergrad, I majored in physics, but I was also doing just about everything I could find on campus. After I got my PhD in solar physics, I began teaching at Swarthmore College. I taught not only the full range of physics courses, but also science and public policy, science and arms control, and similar topics. I had informal discussion groups in my home every week on issues of the day that involved science. I thought, "This is how science and public policy should be done." We want the best understanding of how things actually are—that's what science is all about. Science should not exist all by itself. Scientists should note how their work, and they as people, fit into the larger picture of the world.

How should science and public policy coexist?

I have always straddled these two worlds. At certain times I did more science than public policy and vice versa, but I was always trying to bridge the gap between the two. This has been a very satisfying career for me. But, as I say, it easily could have gone the other way, where I would have been a failure as a physicist and a failure as a politician. For someone who might want to do the same for themselves, it can be risky, but it can also be very satisfying. I think that's where the future of science is—science that is not off in an ivory tower or holed up in a laboratory, but science that is integrated into society. We may get to the point where policymakers who are not trained scientists will be more aware of the science that they need in their policy and won't need to call in the experts, and any well-educated person will be able to think intelligently about science and how that fits into their public questions.

How did you become interested in working with Congress?

I was a congressional fellow, back 40 years ago. The scientific societies, including the American Physical Society (APS) and the American Institute of Physics (AIP), sponsor congressional fellows who are PhD-level physicists. I was mid-career at the time. It is

INTERESTED IN PUBLIC POLICY?

Consider applying to be an AIP Mather Public Policy intern! Mather interns are physics undergraduates who spend the summer working in a congressional office on Capitol Hill, providing support to representatives and staff on a range of issues. Mather internships are part of the Society of Physics Students summer internship program and supported by the John and Jane Mather Foundation for Science and the Arts. Internship applications open November 1 of each year for the following summer. For details visit spsnational.org/programs/internships.

Gia Jadick was an AIP Mather Public Policy intern in 2019 and worked for the US House Committee on Science, Space, and Technology. You can read about her experience at spsnational.org/programs/internships/blog/un-official-non-comprehensive-guide-mather-internship.

HEAR RUSH HOLT LIVE AT 2022 PHYSICS CONGRESS

SPS and Sigma Pi Sigma are thrilled to have Rush Holt in the lineup of amazing speakers for the 2022 Physics Congress. This unique event will bring together hundreds of physics students for three days of talks by luminaries in the field, interactive professional development workshops, and networking opportunities. The Physics Congress will take place October 6–8, 2022, in Washington, DC, and is supported by the American Institute of Physics and hosted by Sigma Pi Sigma, the physics honors society. Anyone interested in physics is invited to attend. For details visit sigmapisigma.org/sigmapisigma/congress/2022.

a terrific program where you spend a year as a staff member on Capitol Hill. It is very different from doing physics, and you have to want to do something different, and you have to be willing to run the risk that it will interrupt your career. About half the people who do the fellowship end up changing their careers because of it, including me, although it took me a while. After my fellowship, I went back to teaching physics and doing research, but I ultimately returned to Capitol Hill.

How has the way scientists engage in public policy changed over the years?

There was a period from the end of World War II to sometime in the 1970s where physicists were the scientists who were most publicly engaged. They were serving on the president's Science Advisory Committee, using their physics analysis to explicate public issues, and publishing articles in the *New York Times*. In recent years, it seems to be more biologists doing this instead of physicists. A few years ago, regarding the Iran nuclear agreement, some physicists got involved, but they were mainly older physicists from that earlier generation.

I think this shift is mainly due to something about the culture that has changed. There are certainly pressing issues in public health today, where the life scientists might have more to say than the physical scientists, but what young physicists want to do and are expected to do has changed. Maybe it's a narrowing of the subdisciplines, where people are devoted to their research. This may have made it harder or less interesting or less expected for young physicists to branch out.

Similarly, how has the way the public engages with science changed?

We have a society where the general public can't think like scientists. I thought the pandemic brought this home especially. The public will be told to wear masks, and they'll either refuse or they won't stop to think for themselves—what are the risks, what are the benefits, and what data do I need to make a decision? They are content to let the scientists do their own research and produce the gadgets that they love. They don't want to meet the scientists halfway, and the scientists don't want to meet the public halfway. The result is, we have a scientific community that isn't connected to society.

A well-developed scientific enterprise in America—which we have—is no substitute for public engagement with science. You can have vaccines, but if people don't trust them and won't take them, or if they refuse to think like a scientist, then public health officials are almost wasting their time. We need to meet in the middle. Scientists will do better science if they think more broadly about what science is, how science works, and how it fits into the world. They will design better experiments and get results that mean more to the world.

What specific education changes can we advocate for to make this a reality?

Most of the emphasis in schools is on teaching science through specific disciplines—biology, chemistry, physics—rather than being taught as science. As a result, you don't get to see the role of one in the other, and cross-disciplinary questions are overlooked. The other thing is, science is taught for future specialists, so we're leaving behind 80% of the population. They don't get to see the beauty of physics, the joys of physics, the usefulness of physics, and they don't learn to think about science.

In everything we do, we should be asking, how do we frame a question so that it can be answered empirically? That's science—it's almost that simple. We should do that at every stage, whether it's studying chemical processes, ecological systems, or physical mechanisms. The goal is not to get bogged down in the details of any particular scientific discipline but to think of science as a way of structuring questions so that they can be answered empirically and verifiably.

What is the single best piece of advice you can give to physics students?

You can be a better physicist if you are not too narrow-viewed. Within physics, there is a lot you can learn from the techniques of high-energy physics or astrophysics that can be helpful in condensed-matter and solid-state physics. But also, more broadly still, if you think more about science and not so much about physics, you can be a better physicist. If you think about how to ask questions so that they can be answered empirically, then you think more creatively about what the questions are and what data you need to collect to answer those questions. It helps you design better experiments. Then, if you put that work into the larger social context, I think you'll be an even better physicist.

What is the role of SPS in your vision?

SPS should be both a forum and a mechanism for broadening physics. Whether in high school or in college, teachers should be reminded that it's a broad community out there. There are many reasons why someone would want to study physics, not only to become a college professor of physics. I would say one of the reasons physics is so wonderful is that it is good preparation for any number of things—even running for Congress, as I did!

Physics is a broad discipline with broad applicability, but many teachers are so focused on the particular mathematical procedures and physical laws that they forget why we are doing this: to understand our world, in a very broad sense. SPS should recruit students who are future doctors, lawyers, environmentalists, and beyond, so that they can remind physics departments to cater to a very large group.

Do you have any book recommendations for students who would like to learn more?

I just published a piece in a reissued version of *Science, The Endless Frontier* by Vannevar Bush. The book starts with an introductory essay from me on the chasm between the scientists and the general public. There are many other great pieces, such as *The Demon-Haunted World* by Carl Sagan, or *Lives of a Cell: Notes of a Biology Watcher*, which is a collection of essays by the biologist Lewis Thomas, or anything by Freeman Dyson. //

SPECIAL FEATURE

From LEGOs to Ziploc: The Science of the Snap Fit

New research reveals how that familiar click of two things locking together works.

by Katharine Gammon, Contributor to Inside Science

This story was originally published by Inside Science, an editorially independent news service of the American Institute of Physics. To see the original version of this article and read more cool science stories, check out insidescience.org.

Pen caps. IKEA furniture. Snaps on a baby's onesie. Our world is filled with everyday examples of the snap fit. That's the term used to describe bringing things together by clicking separate parts. ("Listen for the strong click," my kid's teacher tells them in kindergarten to encourage pen caps to find their proper home.)

Yet as ubiquitous as the snap fit is, the mechanics of how it works hadn't been studied deeply. A new paper changes that, by diving into the physics of snap fits.

Hirofumi Wada, a physicist at Ritsumeikan University, in Kusatsu, Japan began to see snap fits everywhere he looked in the house he shared with his wife and three kids: Lego blocks, Ziploc bags in the kitchen, plastic covers when replacing batteries in kids toys. He started to wonder how it works. Not long after, Wada's student, Keisuke Yoshida, was playing around with objects in the lab, and found a simple cylinder made from a curved sheet of plastic created the dynamics for a snap fit experiment.

The researchers used that system to show a rich variety of snapping behavior, which Wada said was totally unexpected. They used a cylinder and a thin plastic sheet that had been treated with hot water to bend to the shape of the cylinder, and measured the forces at work as the sheet bent over the cylinder and eventually slammed into place. They identified at least four different sequences as the snap happened –the strongest force happened when the sheet bent wildly, about to click into place. The paper was published last fall in the journal *Physical Review Letters.*[1]

"We are physicists and like to study a simplified system in detail," said Wada. He said that while the team doesn't have a specific application in mind, they hoped to reveal how a snap fit may function at its simplest level, which could be useful for creating better industrial designs in the future.

In any snap system, the key thing is that you want it to be easy to push on and harder to pull off—known as the locking ratio—said Dominic Vella, an applied mathematician at Oxford University in the U.K., who was not associated with the new paper. He added that the new paper shows how getting a good snap fit depends on the interaction between the geometry of the object and its ability to deform and then return to its original shape.

The research combines beautiful work: a simple experimental setup and the collection of striking results, said Pierre-Thomas Brun, a chemical and biological engineer at Princeton University, who wasn't involved in the research. "That's the signature of this lab—using super-elegant tabletop experiments which unpack a lot of interesting and not necessarily simple results," he said, adding that the project takes mundane objects and shows that there is more than meets the eye.

While it focuses on the fundamentals, the paper does mention a few new applications where snap fits could take the place of excess plastic or glues that are harmful to the environment. If pieces of construction materials could simply lock together in place, there would be no need for adhesives to stick them together.

Another potential application is in robotics. Instead of grasping an item—something that has proven to be tricky—a robot in a warehouse or on a job site could simply click-lock onto an object. It wouldn't work for helping humans move from the bed to the shower, but could be used for moving groceries or packages. "It's an easy way to grasp on to a crate and move it somewhere," said Brun.

There's not a really good answer to why physicists haven't gotten inside the question of snap fits before, said Vella. One reason could just be that these systems have worked—and there wasn't much impetus to investigate why. "You try it, it works and so people might not feel the need to go deeper than that," said Brun. "But of course, when you go deeper, you can have a better understanding of the fundamentals of these things and in turn that can lead to more optimized applications."

Wada is also interested in investigating what he calls the "type-II snap" which has the opposite qualities: it's easier to pull apart and challenging to push together. He thinks it could be a building block for new metamaterials. He's also interested in rigorously investigating how a plastic ball joint works. "In any structure, form and function are always intimately coupled and much needs to be studied from the viewpoint of physics." //

1. Yoshida, Keisuke and Hirofumi Wada. "Mechanics of a Snap Fit," *Phys. Rev. Lett.* 125, 19 (6 November 2020). DOI:https://doi.org/10.1103/PhysRevLett.125.194301.

Photo by Korena Di Roma Howley.

Lessons on Reading Physics Journal Articles

by Kendra Redmond, Editor

ABOVE: Recent scholarly physics and astronomy publications. Photo by Brad Conrad.

Half an hour until class and only a three-page journal article to read. No problem, right?

Well, let's just say that when the professor asked for a summary of the article I had just read (twice), I had nothing to offer. First lesson learned: journal articles are not light reading.

In the years since that day, I've read and written stories about hundreds of physics, astronomy, and materials science journal articles. In hopes of making your journal article reading experience a little less painful, here are a few more lessons I've learned along the way.

1. PREPARE FOR AN EXISTENTIAL CRISIS.

I'm joking, but only partly. Journal articles are often written in dense technical jargon containing seemingly mysterious equations and inferences. Trying to decipher them can trigger feelings of inadequacy and impostor syndrome reactions[1]: *Why can't I understand this? What's wrong with me? I don't belong here. Everyone else is so much smarter than me. I need a new major!* If that happens, be ready.[2] Take a deep breath. Remind yourself that these feelings don't reflect reality (because they don't), and combat them in a way that's effective for you. For example, make a list of your accomplishments, repeat a mantra (*I know I can figure this out, it will just take time*), take a break until you're more rested, get some exercise, reach out to a mentor, or have a venting session with friends.

2. THE MAIN POINT OF READING THE ARTICLE MAY NOT BE WHAT YOU THINK IT IS.

A common misconception is that the goal of reading a journal article is to fully understand the process by which the authors did what they're writing about. That might be the case if you're elbow-deep in research on the same topic, but if you're reading for a class assignment, journal club, or background information, it's usually more important to focus on the big picture—the *what* and *why*—and to be able to briefly summarize the *how* than it is to understand every variable in every equation. Instead of trying to understand every sentence, try reading to answer these questions: *What problem is the authors trying to solve? What's their general approach? How successful was that approach?*

3. THE ABSTRACT ISN'T NECESSARILY YOUR FRIEND.

In a perfect world, the abstracts of physics journal articles would be great little summaries accessible to anyone with a physics background. We don't live in that world. Abstracts often do a good job highlighting the key points of the research, but many lack the context to be meaningful on their own except to experts in the field. If an abstract isn't working for you, just skip it and move on. You can always come back to it later.

4. COLORED GEL PENS WON'T WIN THE BATTLE.

Underlining and color-coding relevant information can be helpful, but to really get into an article it helps to have a comprehensive strategy. A quick online search for "reading a scientific paper" will point you toward several approaches. Here's what works for me. Each time I need to understand a new paper, I fill in the same simple outline as I read from beginning to end. If something seems important I write it down, even if I don't fully understand it yet.

I. General Information: Who did the research and where? What's the research topic? Is the research experimental, theoretical, computational, or a combination of approaches?
II. Research Goal: What are the researchers attempting to do—constrain a value, characterize a sample or instrument, make a measurement, analyze observational data, refine a model, or something else?
III. Background: Why is this research goal important? What's the context for this work?
IV. Method: What did the researchers actually do, in broad strokes?
V. Results: What did they find? What are the implications?

After I've gone through an article once, I look through my notes. I get rid of irrelevant details, look up key words or ideas that I don't know, and reorganize the information in a way that makes sense to me. If I'm still totally confused, I put down the paper and get more background information on the research area. Once the outline starts coming together, I fill in any holes by going back to the paper and, if necessary, looking at the authors' websites (many include a research overview), the websites of the lab groups involved, and press releases or university/lab news articles associated with the paper (eurekalert.org is a good resource for press releases). After I can summarize in simple terms what the researchers did and why, I go back into the paper and pull out any technical details I need.

This strategy works for me and my goals, but you may need to experiment to find out what helps you get the information you need most efficiently.

5. IT'S NOT ALL IN THERE, SO STOP LOOKING.

Most academic papers represent months or years of intense effort. There's just no way that a three-page article can be comprehensive. If you need a thorough understanding of how the researchers got from A to B to C to D, reach out to your professor, research advisor, or even the authors—in all likelihood they will be thrilled that a student is expressing interest and happy to answer your questions.

Effectively reading academic journal articles is a skill that takes time to develop—give yourself grace, and take your time. Appreciate the well-written articles and work on developing a clear writing style yourself. Tomorrow's undergraduate physics students will thank you! //

NOTES

1. People with impostor syndrome have recurring doubts about their competence and worry about being outed as a fraud, despite their successes. The impostor syndrome is especially common among people from groups that are underrepresented in the field.
2. For more information on this, see Loren Soeiro, "How to Cope With Impostor Syndrome," *Psychology Today*, August 22, 2019, psychologytoday.com/us/blog/i-hear-you/201908/how-cope-impostor-syndrome.

Innovation, Growth, and Global Impact:

How AAPM and COMP Adapted to COVID-19

by Michelle de Oliveira, SPS Member, Wheaton College

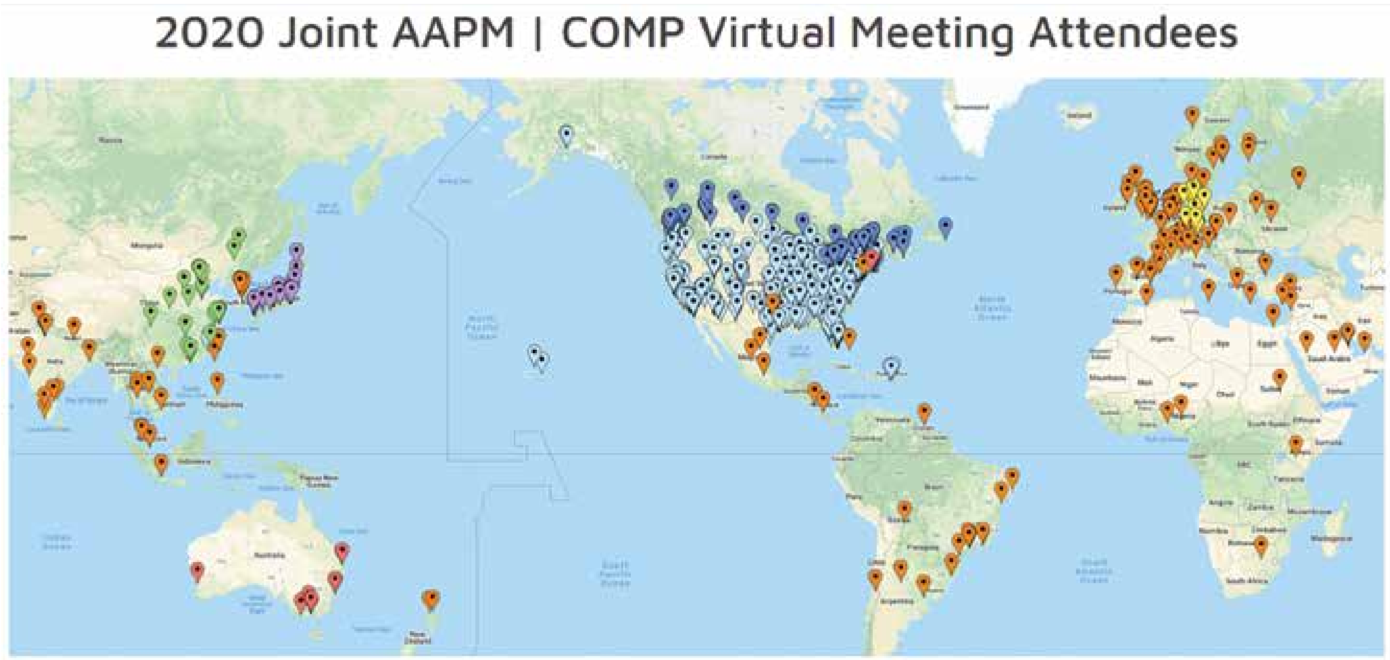
The bustling conference hall is temporarily extinct. In the wake of COVID-19, the joint meeting of the American Association of Physicists in Medicine (AAPM) and the Canadian Organization of Medical Physicists (COMP) went from being in Vancouver to being completely virtual. The clicking of a mouse replaced the rhythmic clacking of a suitcase on airport tile, while the confused turning of an exhibition hall map became the navigation of unfamiliar online platforms. For four days last July, 3,677 registrants participated in online lectures, a multimedia exhibition hall, discussion panels, chat rooms, competitions, and social events.

As an undergraduate student in applied physics whose experience with professional physics conferences was limited, I was worried that the AAPM|COMP experience would be just another blue screen. However, AAPM took charge of the online meeting and went above and beyond my expectation, creating a fully interactive website designed for and by medical physicists to ensure the best possible online conference experience.

ABOVE: Michelle de Oliveira. Photo courtesy of the author.

In his message, AAPM's then president, M. Saiful Huq, acutely stated that the pandemic has affirmed "Global health is local health and local health is global health. As one of the largest organizations of medical physics, the AAPM|COMP participants are tasked with the herculean level of innovation necessary to combat any disease for the betterment of all of humanity. In a time such as 2020, this call is even more relevant." This call for the drastic improvement of global health and eliminating global disparities reverberated throughout the event. Topics ranged from hard skills such as those used in diagnostic, imaging, and therapy physics, to softer skills like residency mentor-mentee relationships, social media, and alternative educational tracks. However, all these topics resonated with the same note, described by Huq as developing "strategies to close the gap in standard imaging and cancer therapy procedures" for increased global impact.

Conferences were primarily prerecorded, with the presenters in the audience for a live question-and-answer session. Throughout the week, there was also a live chat box that allowed attendees to pose new questions to presenters. One of the many benefits of the online platform was that sessions were recorded and posted on the meeting website until



TOP: Michelle de Oliveira, SPS reporter. Photo courtesy of the author.

ABOVE: A map showing the locations from which AAPM|COMP attendees participated in the virtual meeting. Image courtesy of AAPM|COMP.

ABOVE: M. Saiful Huq speaks during the 2020 Joint AAPM|COMP Presidential Symposium: "Improving Health Quality, Increasing Global Impact." Photo courtesy of Michelle de Oliveira.

six weeks after the conference, removing the stress of picking the right sessions to attend. It was easy to hop out of meetings if necessary, as well as catch the recordings of sessions that happened simultaneously.

And while live sessions can fill up due to platform performance capacity, anyone can revisit recorded sessions. This feature is valuable for popular topics such as FLASH radiation therapy, which first gained steam at the 2019 AAPM meeting. This year's sessions also included a presentation on ionizing radiation with ultrahigh dose rates (coined FLASH radiotherapy or FLASH-RT) and its link to drastically reducing side effects while maintaining tumor control. A session on the clinical translation of FLASH radiation therapy filled up quickly after opening, but thanks to its virtual format, those who didn't get in were able to view the recorded session later.

I found especially refreshing the social hour discussion, "Pushing the Envelope of MRI in Radiation Therapy." This Zoom call, dedicated to unwrapping current efforts to enhance the integration of MRI in radiation therapy, included discussion of treatment planning as well as MR-guided deliveries. After a brief introduction of state-of-the-art national and international standardization efforts, followed by a description of novel ongoing clinical trials, a facilitated open-board discussion and crowd-sourced survey led to a review of the perceived areas of unmet need. During this discussion, the raw innovation, excellence, and open-minded framework of medical physics was highlighted. It was clear that the medical physics community's focus was on meeting global needs, adapting to the ever-evolving technology, and growing expertise in upcoming areas.

Of course, conferences shouldn't be all work and no play. AAPM took full advantage of its online platform to engage with attendees. Instead of abandoning its annual fitness challenge and scavenger hunt, the organization turned to fitness-tracking apps and Twitter to catalog points and fundraiser amounts, giving away YETI merchandise to winners announced on Twitter using #AAPMCOMP2020. Recognizing that many participants were quarantined with their families, organizers also held a physics storybook reading hour to encourage the minds of young and veteran physicists alike.

As previously mentioned, many users took to Twitter, a platform with growing popularity among medical physicists, to engage with fellow AAPM members, set up alternative events, and even give IT advice, tagging #AAPMCOMP2020. Conveniently, physicists less acquainted with the social media site could attend an early-Monday-morning panel discussion hosted by several prominent medical physicists on Twitter, including AAPM's current treasurer Mahadevappa Mahesh. Here they tackled getting started on social media and its benefits while providing prime examples of medical physicists and radiation oncologists who have successfully used Twitter around the globe. They even broke down ways to find catchy and clever Twitter handles, such as that of AAPM's current president, @HuqedOnPhysics.

Twitter was also where many attendees expressed how they felt about the online shift. Although many expressed disappointment at missing out on travel, the reception was overwhelmingly positive, with many photos of dogs, cats, and kids crowding around medical physics presentations. It was funny to see an official conference page littered with memes and Bill Nye. Some users expressed their happiness at being able to jog while listening in on lectures, while one user left a session early to sing "Happy Birthday" to their son. Numerous parents expressed how they were thrilled to be able to attend without worrying about childcare.

Accessibility was significantly increased with the virtual format, as noted by the attendance of participants from all over the world (see map) and several Tweets. Lisa Glass, a radiation therapy physicist from Saskatchewan and regular attendee of COMP meetings, was able to take advantage of AAPM|COMP's programming exclusively because it was online. Like many other attendees, Glass enjoyed the in-person interaction during Zoom meetings, stating that "breakout groups were so randomly selected you met people you probably would not have interacted with otherwise," gaining a plethora of different perspectives. It may not have been the same as in-person networking, but as one individual pointed out on Twitter, at least it meant they didn't have to wear shoes.

All and all, I had a fantastic first AAPM|COMP experience that encouraged a greater understanding of what it means to be a medical physicist, specifically in response to growing need. If nothing else, AAPM|COMP's adaptation to the online platform proves that medical physicists do what they claim they do: acknowledge the changing technological climate and adapt to better suit the needs of the world around them. I'm excited to see what creative things AAPM can think up for its 2021 meeting in Cleveland, Ohio. //

the SPS Observer
American Institute of Physics
1 Physics Ellipse
College Park, MD 20740-3841

Start Celebrating 100 Years of Momentum with Sigma Pi Sigma!

The 2022 Physics Congress is coming up fast. Stay in the know by joining the SPS Discord server. In the new PhysCon Hype channel, you'll find PhysCon updates, behind-the-scenes information, and fellow physics majors preparing for the 100th anniversary celebration of Sigma Pi Sigma! This meeting is specifically for you!

Registration is now open: **www.sigmapisigma.org/congress/2022**

AIP
American Institute of Physics

SPS