

the SPS Observer

Volume LV, Issue 3

WINTER 2022



+ From Leonardo to NASA
and Back Again

+ A Virtual Take on What's
Hot in Physics

+ Multichapter Event Lifts Spirits,
Builds Community

+ Demonstrating Wastewater
Remediation with Solar Technology

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ON THE COVER

Radford University physics major Kaleb Martin performs an experiment to measure the electron's charge-to-mass ratio. The magnetic field generated by Helmholtz coils stabilizes an electron beam in a circular path for the measurement. Here Martin watches the electron beam as it is distorted from its circular path by a permanent magnet on the right, between the Helmholtz coils. Photo by Rhett Herman.

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- American Physical Society
- Acoustical Society of America
- AVS: Science & Technology of Materials, Interfaces, and Processing
- Optica (formerly known as OSA)
- The Society of Rheology

Other Member Organizations:

- Sigma Pi Sigma physics honor society
- Society of Physics Students
- Corporate Associates

We Make SPS Each Day

by Brad Conrad, Director, SPS and Sigma Pi Sigma

One hundred years ago this year, physics students and faculty at Davidson College came together to form a new organization. While the details have evolved, the mission of what they created has remained the same: support all undergraduate students with an interest in physics and astronomy. We're in the midst of one of the hardest times in a generation to be a physics or astronomy major, but this clear and focused purpose helps us respond to the trials and tribulations of a new era. We will persevere the way we always have—by encouraging one another and supporting a wide variety of activities.

Just as each department is different, each physics and astronomy major may benefit from a different set of activities in pursuit of their dreams. This issue of the *SPS Observer* will touch on just some of the inventive, awesome, and impactful activities chapters are doing to support their members and communities in the areas of community-building, research, professional development, and outreach. If you've ever wanted to know why SPS is special, this is the issue for you.



Physics and astronomy departments are built on a foundation of students and faculty. The glue that keeps us all together is tradition and a sense of shared belonging. Ideally, each new major should say to themselves, "These are my people. They get me." As a first-generation college student hundreds of miles from where I grew up and with no backup plan, having an SPS community to call home kept me in college. That was where I could explore who I might want to be and escape from the million other stresses I had.

RIGHT: The University of Illinois Urbana-Champaign's SPS chapter builds community one hand at a time. All photos courtesy of the corresponding chapter's 2020–21 SPS chapter report.



Physics is an experimental science, and no matter whether you plan to go into industry or graduate school, or take a different path upon graduation, research is invaluable. And research is a place where some SPS chapters really shine. Undergraduate research in physics and astronomy takes many forms, but it helps to prepare us all for the challenges that lie ahead—problem solving when there is no answer to look up!

LEFT: Members of the Augustana Physics and Engineering Society construct a cardboard regatta.



Faces of Physics
Virtual Speaker Series
Sign up for email updates!
Visit <https://www.marshall.edu/physics/society-physics-students/> for more details!

Dr. Natalia Lewandowska
Haverford College

Karen Perez
Columbia University

Dr. Bryan Kent Wallace
Fisk University

Dr. Abel Méndez
University of Puerto Rico
at Arecibo

Dr. Kandice Tanner
National Cancer Institute

Pranav Sanghavi
West Virginia University

THE SPS OBSERVER WANTS TO SHOWCASE YOUR CHAPTER!

Reflect on your SPS year, invest in the future of your chapter, and let us know what you've been up to by submitting your 2021–22 SPS chapter report by June 15. For details visit spsnational.org/resources/chapters/annual-chapter-reports.

LEFT: Marshall University's SPS chapter hosts an ongoing virtual speaker series.

BELOW LEFT: Members of Colorado Mesa University's SPS chapter prepare for an outreach event.

One of the best ways to experience what makes SPS special is through the chapter showcase at the 2022 Physics Congress. During the showcase, chapters can put on display all the awesome things they've worked on, accomplished, and cultivated that make their chapter unique. The first showcase was at the 2019 Physics Congress—I've never seen anything like it before. It was magical!

Join us for the 2022 showcase at the upcoming Physics Congress to be inspired by creative ideas, see awesome demos, show off nerdy T-shirts and stickers, and see real-life examples of how chapters build community, connect to alumni, and help their members succeed beyond the classroom. You don't want to miss this. Check out sigmapisigma.org/sigmapisigma/congress/2022 for details.

In the meantime, enjoy this chapter showcase issue, highlighting activities from the 2020–21 SPS chapter reports. I hope it inspires you to get out and try out something new this year! //

REGISTER FOR THE 2022 PHYSICS CONGRESS TODAY!

Early bird prices end September 6, 2022.

For more information, visit sigmapisigma.org/congress/2022.



It was through SPS that I gave my first talk, led my first meeting, and learned what it meant to be a physicist and astronomer. During most of college, I felt like I had gotten in by accident because I had NO CLUE what was expected of me. I wasn't prepared for all of the situations in which I was being asked to excel. Yet the skills I learned during our colloquium series, SPS professional development events, and as a club officer gave me the foundation I needed to stop feeling like an outsider.



The vast majority of physics and astronomy departments serve their local communities through outreach events or other activities. SPS chapters host high school boot camps, K-12 demo days, food drives, and holiday-themed events to help get others as excited as they are about science. And their events make a lasting impact in the lives of students, teachers, and parents.

Meet the 2021 SPS Outstanding Chapter Advisor: Donna Hammer

by Kendra Redmond, Editor

The SPS Outstanding Chapter Advisor Award is the most prestigious award given by SPS, bestowed annually on the basis of the leadership, student leadership development, support, and encouragement the advisor has provided to the chapter. For her leadership and guidance of the SPS chapter at the University of Maryland, College Park (UMD), Donna Hammer is the 2020–21 SPS Outstanding Chapter Advisor.

Donna Hammer is director of education for the physics department at UMD, which includes a variety of diverse roles. From organizing physics conferences to developing seminar classes, from recruiting new majors to hosting summer programs for K-12 students, she's always on the move and always working on something new. The one constant: it's all about students.

With 350 physics majors, UMD's physics program is among the largest in the US. One of Hammer's driving principles is to make sure that each student feels welcomed and supported, whether that means creating a physics boot camp for incoming majors, mentoring students through personal challenges, addressing issues of diversity, equity, and inclusion in physics, or empowering students in her role as advisor for SPS and the other student groups in the department.

"SPS has been a huge boost for community building in the department," Hammer says. "The members are a dedicated group. They do all kinds of innovative activities that bring the department together." This includes their legendary donut sales, outreach events, social activities, mentoring, and tutoring services, among other activities. "The tutoring room is the best place to go," says Hammer. "You can look out at all of these students working in groups, and SPS has organized it all."

While Hammer gives the credit to the students, the students credit her passion, dedication, and guidance for their success. "It was Donna's contagious enthusiasm that convinced me to join SPS and get involved in research," explains the student who nominated Hammer. "Since then, I have witnessed both the extraordinary amount of work Donna contributes to SPS as well as her profound effectiveness in mentoring students, including myself."

When classes suddenly shifted online in 2020 due to the COVID-19 pandemic, it was still all about the students. Hammer was in the office from day one, helping chart a course forward and supporting physics students through unimaginable challenges and isolation. Now that the campus has reopened, she's looking ahead to teaching a new seminar on diversity, equity, and inclusion that she codeveloped, hosting a summer full of physics camps, and restarting some of the projects that went on hiatus during the pandemic. Yet, somehow, she always has time to check in with students and make sure their needs are being met.



ABOVE: Donna Hammer (farthest left) with members of the UMD chapter at the 2019 Physics Congress.

As an SPS advisor, she's most proud of the UMD chapter's consistent Outstanding SPS Chapter Awards (eight years in a row!) and their impact on the department. "We have a physics undergraduate research showcase and research fair each year, and SPS has a big role in those events. I'm really proud that we were able to institutionalize, through SPS, those department activities," Hammer says.

Hammer's enthusiasm for her students, her job, and the field of physics is clear. "It's very important that the physics community continues to grow and address inequities. There are questions to answer, problems to solve, and exciting research and career opportunities to pursue for all students with the passion for physics," she says. //



LEFT: Hammer (second from left) and UMD physics students pass out treats during Maryland Day, a family-friendly event on campus. Photos courtesy of the chapter.

OUTSTANDING ADVICE FOR ADVISORS

"Really listen to the students — each group of SPS leaders has a different mission. To help them meet their goals, build them up in the areas where they feel they can make the biggest contribution to the community, where they can shine."

- Donna Hammer, SPS Outstanding Chapter Advisor

SPS 2021

Outstanding Chapter Advisor & Outstanding Chapter Awards

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 themselves, their chapter, and their department and will be officially recognized at the American Association of Physics Teacher's 2022 Winter Meeting. Learn more at spsnational.org/awards/outstanding-chapter-advisor.

Winner:

Donna Hammer

University of Maryland, College Park

Nominees:

Rachele Dominguez

Randolph-Macon College

Costas Efthimiou

University of Central Florida

Walter Johnson

Suffolk University

Jeremy Lusk

University of Central Arkansas

Jason Slinker

University of Texas at Dallas

2020–2021 SPS OUTSTANDING CHAPTER AWARDS

The SPS Outstanding, Distinguished, and Notable Chapters are determined each year by the National Council through careful review of the SPS chapter reports. Designations are made based on chapter involvement in local, zone, and national SPS meetings, participation in SPS programs, outreach efforts, student recruitment, and interaction with their department and department alumni. To earn these designations, SPS chapters are encouraged to stay active and engaged by participating in an array of activities. Sample activities can be found in the SPS Information Handbook, available at spsnational.org/about/governance/sps-information-handbook.

Outstanding Chapters

Zone 1

Brown University (RI)
Mount Holyoke College (MA)
Yale University (CT)

Zone 2

Adelphi University (NY)
Hamilton College (NY)
Ithaca College (NY)
New York University

Siena College (NY)
St. John's University - New York City (NY)
SUNY - Stony Brook University (NY)
University of Rochester (NY)

Zone 3

Juniata College (PA)
Lycoming College (PA)
Rutgers University - New Brunswick (NJ)

University of the Sciences in Philadelphia (PA)

Zone 4

Georgetown University (DC)
Howard University (DC)
Northern Virginia Community College
Old Dominion University (VA)
Radford University (VA)
Roanoke College (VA)
The George Washington University (DC)
University of Maryland, College Park

Zone 5

Appalachian State University (NC)
Davidson College (NC)
University of North Carolina at Asheville
University of North Carolina at Chapel Hill

Zone 6

University of Central Florida
University of Florida
University of North Alabama
University of Puerto Rico - Mayaguez
University of Puerto Rico - Rio Piedras
University of Tampa (FL)

Zone 7

Cleveland State University (OH)
Denison University (OH)
Grove City College (PA)
Kettering University A (MI)
Kettering University B (MI)
Lawrence Technological University (MI)
Marshall University (WV)
University of Pittsburgh (PA)
Wayne State University (MI)
West Virginia University

Zone 8

University of Illinois at Urbana-Champaign

University of Louisville (KY)
University of Tennessee

Zone 9

Augustana College (IL)
Carthage College (WI)
University of Wisconsin - River Falls
Wheaton College (IL)

Zone 10

Dillard University (LA)
Rhodes College (TN)
University of Central Arkansas
University of Southern Mississippi

Zone 11

Coe College (IA)
Luther College (IA)
South Dakota School of Mines & Technology
South Dakota State University
University of Northern Iowa

Zone 12

Missouri Southern State University
Southwestern Oklahoma State University
William Jewell College (MO)

Zone 13

Abilene Christian University (TX)
McMurry University (TX)
Texas A&M University - Commerce
Texas Lutheran University
The University of Texas at Dallas

Zone 14

Colorado School of Mines
United States Air Force Academy (CO)
University of Colorado Denver
University of Denver (CO)

Zone 16

Embry-Riddle Aeronautical University - Prescott (AZ)

Zone 17

University of Alaska Fairbanks
 University of Oregon
 University of Washington Bothell

Zone 18

California State University,
 Long Beach
 California State University,
 Northridge
 University of California, Berkeley
 University of San Diego (CA)

Distinguished Chapters

Zone 1

Fairfield University (CT)
 Saint Anselm College (NH)
 Suffolk University (MA)
 University of Maine
 Worcester Polytechnic
 Institute (MA)

Zone 2

Manhattan College (NY)
 Rochester Institute of
 Technology (NY)
 SUNY Potsdam (NY)
 The City College of New York
 University at Albany (NY)
 University at Buffalo (NY)

Zone 3

Bryn Mawr College (PA)
 Drew University (NJ)
 Moravian University (PA)
 Rowan University (NJ)
 Saint Joseph's University (PA)
 Stockton University (NJ)
 The Pennsylvania State University

Zone 4

College of William & Mary (VA)
 Longwood University (VA)
 Randolph College (VA)
 Randolph-Macon College (VA)
 University of Mary
 Washington (VA)
 University of Maryland,
 Baltimore County
 University of Virginia
 Virginia Polytechnic Institute and
 State University

Zone 5

Duke University (NC)
 High Point University (NC)

Zone 6

Florida Polytechnic University
 Georgia Institute of Technology
 New College of Florida
 University of North Georgia

Zone 7

Allegheny College (PA)
 Duquesne University (PA)
 Gannon University (PA)
 Kenyon College (OH)
 Michigan State University
 Ohio Wesleyan University
 Ohio University
 University of Dayton (OH)
 University of Michigan
 University of Toledo (OH)

Zone 9

Ball State University (IN)
 Saint Norbert College (WI)
 University of Wisconsin -
 Eau Claire

Zone 11

Augustana University (SD)
 Bethel University (MN)
 Creighton University (NE)
 Minnesota State University
 Moorhead
 University of Minnesota -
 Twin Cities

Zone 12

Oklahoma State University
 Truman State University (MO)
 University of Missouri - Columbia

Zone 13

Angelo State University (TX)
 Stephen F. Austin State
 University (TX)
 Texas A&M University
 University of Dallas (TX)

Zone 14

Colorado Mesa University
 Fort Lewis College (CO)

Zone 15

University of Utah
 Westminster College (UT)

Zone 16

Arizona State University

Zone 17

Highline College (WA)

Zone 18

California Lutheran University
 California State University,
 Sacramento
 Point Loma Nazarene
 University (CA)

Notable Chapters

Zone 1

Bridgewater State University (MA)
 Saint Michael's College (VT)
 Smith College (MA)

Zone 2

Buffalo State College (NY)
 Hofstra University (NY)
 Roberts Wesleyan College (NY)
 Syracuse University (NY)

Zone 3

Drexel University (PA)
 East Stroudsburg University (PA)
 Georgian Court University (NJ)
 Lehigh University (PA)
 Ramapo College of New Jersey
 Saint Peter's University (NJ)
 Seton Hall University (NJ)
 Stevens Institute of
 Technology (NJ)
 Temple University (PA)

Zone 5

Furman University (SC)

Zone 6

Universidad Autónoma de Ciudad
 Juárez (Mexico)
 University of West Florida
 Wallace Community College (AL)

Zone 7

Hillsdale College (MI)
 Kalamazoo College (MI)
 Miami University (OH)

Zone 8

East Tennessee State University
 Indiana University Bloomington
 Murray State University (KY)

Zone 9

DePaul University (IL)
 Marquette University (WI)
 University of Illinois Chicago
 University of Wisconsin -
 Parkside

Zone 10

Louisiana Tech University

Zone 11

Nebraska Wesleyan University
 University of Nebraska Lincoln
 University of Northern Iowa

Zone 12

Pittsburg State University (KS)

Zone 13

Southern Methodist
 University (TX)
 Texas Tech University
 Trinity University (TX)
 University of Texas at
 San Antonio
 University of Texas Rio Grande
 Valley - West

Zone 16

University of New Mexico

Zone 17

Lewis & Clark College (OR)
 Reed College (OR)

Zone 18

California State Polytechnic
 University, Pomona

**UPCOMING SPS AWARD
 APPLICATION DEADLINES**

March 15

- SPS Award for Outstanding Undergraduate Research
- SPS Scholarships

June 15

- SPS Outstanding Chapter Award
- SPS Outstanding Chapter Advisor Award

Ongoing Awards

- AIP-SPS Pandemic Scholarship
- Food for Hungry Physics Students

For details on all SPS awards visit spsnational.org/awards.



SPS Chapters on **BUILDING COMMUNITY**

- 1: Bethel University SPS members carve physics equations into pumpkins while social distancing.
 - 2: Roanoke College SPS members enjoy the beauty of Southwest Virginia on a hike.
 - 3: Sacramento State University's SPS members commemorate graduation.
 - 4: University of Denver SPS chapter members show off the aurora borealis masterpieces they painted during a virtual Bob Ross Painting Night.
 - 5: Members of Truman State University's SPS chapter attend the All-Science Picnic, which encourages socialization across science majors.
- All photos courtesy of the corresponding chapter's 2020–21 chapter report.

Multichapter Event Lifts Spirits, Builds Community

by Levi McClurg, Past SPS Chapter President (2020–21), Point Loma Nazarene University

Pandemics don't stop physics.

It was the fall of 2020, the thick of the COVID-19 pandemic, and there were few gatherings of any sort going on—let alone in the physics community. But three SPS chapters in Southern California somehow pulled off a joint virtual event featuring physics Nobel laureate Dr. William (Bill) Phillips. Phillips works at the National Institute of Standards and Technology (NIST) and gave a great talk about international unit reformation.

The event was a collaboration between SPS chapters at the University of California San Diego, California State University, San Marcos, and Point Loma Nazarene University. Chapter members, alumni, and friends from each school gathered over Zoom in numbers any one of us would have struggled to muster on our own.

If you've attended virtual talks before, you probably know how awkward they can be—especially the Q&A section. But all of the attendees can attest to the clarity, brevity, and general charisma of Phillips as a speaker. To our delight, this event wasn't laced with the usual muted-mics and cameras-off silence at the end of the talk. We had an influx of questions right away and ended up going over our 30-minute Q&A allotment to get to all of them.

Pulling off a joint event in the strangest of global circumstances was cause for celebration, even if it had to be held virtually. The fact that a Nobel laureate gave the talk made it an even more meaningful time for the students, alumni, and faculty in attendance.

Ironically, the COVID-19 pandemic is part of what made this event possible. The geographic separation of the three SPS chapters from each other and from Phillips means the chances of an event like this happening in ordinary times—when the default would have been an in-person talk—are slim to none. Our chapter is eager for more joint events and has realized that it's easier than we thought to organize a virtual one.

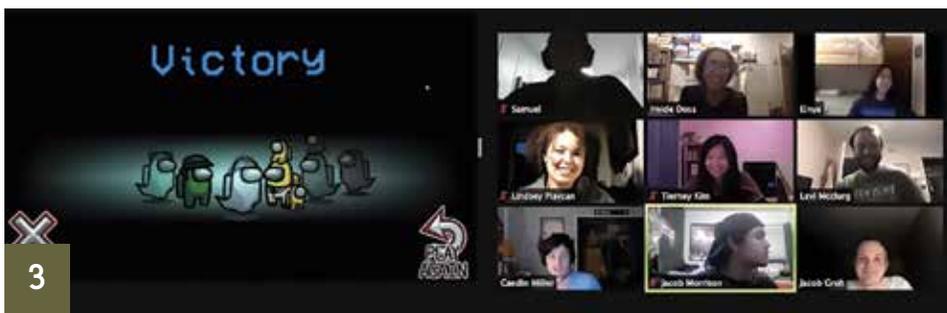
We hope this experience serves as a catalyst for further collaborations between SPS chapters, whether they be fun activities, professional physics talks, or anything in between. Joint events have the potential to create and foster lasting relationships across campuses between physics enthusiasts. After all, we call it “the physics community” for a reason. //



1: William D. Phillips received the 1997 Nobel Prize in Physics for developing methods to cool and trap atoms with laser light. He's a great friend of SPS and is shown here at the 2019 Physics Congress. Photo courtesy of SPS National.



2: In 2018 the kilogram was redefined in terms of the Planck constant, ending our reliance on physical artifacts to define SI units. That transition was the subject of Bill Phillip's talk. Shown here is a platinum-iridium kilogram mass housed at the National Institute for Standards and Technology (NIST), with stainless-steel masses in the background. Photo courtesy of J.L. Lee, NIST.



3: SPS members from Point Loma University hang out during a virtual event, an Among Us social.



Pandemic Brings Unique Spirit-Wear Opportunity

by Samantha Tietjen and Andrew Scherer, SPS Members, Cleveland State University

Cleveland State University (CSU) completed its spring 2020 semester online and had extremely limited on-campus capacity for the 2020–21 academic year. While the COVID-19 shutdown was an unprecedented experience for everyone, it did have some unexpected silver linings.

Prior to the pandemic, we had discussed redesigning our chapter T-shirt to better represent the next generation of SPS officers and members. However, mandatory masking presented an interesting opportunity. With a push from our chapter advisor, Dr. Streletzky, we decided to pitch a small change of plan. Rather than make new T-shirts, how about SPS-themed masks? With the then-proposed return to partial campus activities, it seemed more timely than a T-shirt update.

Several designs were pitched by officers, including science puns, colorful decals, and a patterned mask. Ultimately we decided that the best design was the simple, but well-loved chapter logo. The masks would serve as a form of chapter pride for members as well as an effective advertising opportunity—they would be worn around campus when the classes and labs were allowed to reopen.

The hardest part of making this pitch a reality was obtaining funding for the project. Department funds were tight. Pandemic-related budget restrictions were affecting all CSU operations. But as safety measures and vaccine rollouts began to pick up across the country, CSU was able to open up more parts of campus. This meant some funding

was available to student organizations. Once we had the money, the mask order went in. There was some extra processing time caused by pandemic slowdowns, but they arrived just in time for the end of the fall semester.

The masks were well received by CSU's SPS members and faculty. The initial batch were given out as prizes for the winners of the 2021 online version of Physics Jeopardy. They were also sported by the spring 2021 graduating physics majors during the first in-person commencement ceremony since the start of the pandemic. The chapter's masks definitely stood out on the jumbotron as SPS students received their hard-earned diplomas at the end of one of the most bizarre academic periods in recent history.

While they may not be the most standard piece of chapter pride, the masks are certainly the most unique we've had to date. They'll serve as a reminder for years to come of this extraordinary period in the chapter's, and the world's, history. //

ABOVE LEFT: CSU's mask design by Andrew Scherer, featuring a logo drawn by Samantha Tietjen.

ABOVE RIGHT: Samantha Tietjen wears an SPS mask during the 2021 Spring Commencement ceremony held at Progressive Field. Photos courtesy of Tietjen.

A New Take on a Family Tradition

by Kirk Kleinsasser, SPS Chapter Secretary and Past Chapter President (2020–21), Lycoming College



For an afternoon each semester, the Lycoming College SPS chapter and physics faculty gather for a family-style picnic and an afternoon of games. Hosted by our department chair in his home, this event is a highlight of the semester. Everyone enjoys the chance to relax and de-stress in a warm and welcoming environment, and it's also an opportunity to welcome new members into our physics family.

Unfortunately, the last few semesters have been highly unusual. In 2020, Lycoming College conducted face-to-face instruction, but extracurricular events were limited. By fall, clubs and organizations weren't permitted to hold off-campus events due to the risk of spreading COVID-19.

We didn't want to abandon one of our favorite bonding experiences unless absolutely necessary, so our executive board quickly decided to host the event on campus. We knew it would be challenging to plan safe and fun activities, so we started months in advance.

Lycoming had approved only institution-led events at that time, so we needed special approval to host the picnic. While approval was pending, we planned contact-free activities, stringent disinfectant and sanitary practices, and social distancing accommodations. Naturally, we required face coverings, which fell in line with our Halloween theme.

Despite our early planning, we received final approval just a few days before the event, as campus management needed to ensure that case numbers and transmission risks were sufficiently low. Our picnic was the only student-led, in-person event approved by Lycoming College for the fall.

Still, we had to make last-minute accommodations. It rained the day before the event, forcing us to move locations. We had to cancel our plans for catered food. We decided to open the event to the entire campus and didn't have enough funding for that much food.

Even with all these challenges, our members had a blast. We were happy just to see each other face-to-face outside of class! Several of the physics faculty joined us for the afternoon, bringing candy and company. Instead of a meal, we handed out treats and hot chocolate. We played games and held a costume contest where fan favorites won Starbucks gift cards. We were especially happy that many new members joined us for the first in-person SPS event of the year. //

TOP TWO: Lycoming College SPS members enjoy socializing outside of class at the 2020 fall picnic. Photos courtesy of the chapter.

MIDDLE: SPS leaders from Lycoming College pose for a COVID-19-safe group photo. Photo by Mitch Wheary, Lycoming College.

BOTTOM: With off-campus events allowed again, Lycoming College SPS members visit a local park for stargazing. Photo courtesy of the chapter.

Whodunnit: A Murder Mystery for the SPS History Books

by William Aaron, Morgan Kaler, Brigitte Lefebvre, Sebastian Pineda, and Michelle Sangillo, SPS Members, Worcester Polytechnic Institute

As it turns out, famous physicists are quite a murderous bunch! At least that's what we, the Worcester Polytechnic Institute (WPI) SPS chapter, decided when we created an SPS murder mystery game. The idea was sparked by our monthly Physics Story Time events, run by chapter activities director William Aaron. As the name suggests, Physics Story Time explores the lives of famous scientists, such as Paul Dirac and Cecilia Payne-Gaposchkin, through engaging storytelling and visuals. The stories were easy to present over Zoom and were a welcome addition to our online chapter meetings in 2020.

While looking into the history of Enrico Fermi for a Story Time, we discovered a real-life mystery—the 1938 nautical disappearance of famed neutrino particle physicist Ettore Majorana, who had belonged to an Italian research group led by Fermi. Our imaginations ran wild, envisioning murders, secret codes, and grand conspiracies set in the heart of the 20th century. Inspired, we set out to create a role-playing murder mystery event for which participants would play historically famous physicists, investigate clues, interview suspects, and catch the murderer. Note: Although inspired by Majorana's real disappearance, we made up the storyline!

The setting was a 1938 Italian cruise. We had seven characters: Paul Dirac, Cecilia Payne-Gaposchkin, Emmy Noether, Enrico Fermi, Giovanni Gentile Jr., Henrietta Swan Leavitt, and Werner Heisenberg.



■ ABOVE: Image courtesy of the chapter.

Each participant received a sheet with their character's biographical information, their whereabouts at various times on the cruise ship, and a hidden dark secret. Participants didn't know their character's dark secret at the start—it could only be revealed after uncovering enough clues or red herrings. That way, everyone could take part because nobody knew whether their dark secret was murder or some other nefarious deed!

Playing detective Hercule Poirot, Aaron revealed to participants that Majorana's body had been found in the ship's dining hall. He announced, "Everyone is a suspect, and we all must investigate together." In the spirit of Agatha Christie's famous sleuth, he led the party in investigating the items in each room while the physicists questioned each other's alibis. Alliances quickly formed, and many clues were vigorously examined and hilariously misinterpreted. Was Enrico Fermi a bloodthirsty killer? Nope. His dark secret was being a kleptomaniac. Was Emmy Noether a homicidal maniac? No, she was just an arsonist. Was Henrietta Swan Leavitt a dastardly murderer? Strangely, her dark secret was that she was a ghost who had died 17 years ago!

At the end of our event, Giovanni Gentile Jr. was revealed to be responsible. As our story goes, he had worked hard to achieve candidacy for a physics professorship in Italy, only to be unseated once Majorana returned from his international studies. Fortunately for Gentile, his father was an important philosopher and political ally to Benito Mussolini, who was more than happy to "take care of Majorana." With his misdeeds revealed, Giovanni leapt into the ocean to escape the vindictive crowd of physicists, and so ended our investigation.

In reality, it's unknown whether anything nefarious caused Majorana's disappearance. In 2011 the Rome Attorney's Office stated that, based on a picture and eye witnesses, Majorana was believed to have been alive and living in Venezuela in the 1950s. Authorities presume he migrated there voluntarily. For some, however, the explanation isn't entirely satisfying, and many questions remain.

With the success of our first Murder Mystery Night, we're excited to make this an annual tradition and plan a new mystery for this academic year. It seems that a good mystery has a knack for bringing scientists together. All in all, the event was a great way for us to bond and have fun in the midst of the pandemic. //

Shifting a Department Culture

by Samantha J. H. Berry, SPS Chapter President, and Lily Goltz, SPS Chapter Vice President, Bryn Mawr College

“I’ve learned that people will forget what you said, people will forget what you did, but people will never forget how you made them feel.” – Maya Angelou

We went on strike a year ago. Students, faculty, and staff at Bryn Mawr College and Haverford College, our partner school, abstained from work and studies in solidarity with the BIPOC (Black, Indigenous, and People of Color) members of our campus who are underrepresented and undersupported in our community.

Among the 18 strike demands were calls for transparency, reparations, and administrative change. A lot of ugly truths were uncovered during the strike. A big one was the lack of effective equity, diversity, and inclusion efforts in our physics department.

As a step toward change, our department then joined the American Institute of Physics (AIP) TEAM-UP program as a departmental team. TEAM-UP, the AIP National Task Force to Elevate African American Representation in Undergraduate Physics & Astronomy, released a report in 2020 that addressed the ongoing underrepresentation of African Americans in these departments. It details systemic issues contributing to the underrepresentation and provides actionable recommendations for reversing the trend.

TEAM-UP found that the main factors that contribute to the success of African American students in physics and astronomy departments are a sense of belonging, physics identity, academic support, personal support, and leadership and structures. Departmental teams acknowledge the grave importance of these factors and commit to implementing the findings from this report.

Our departmental team consisted of the entire faculty plus graduate and undergraduate representatives. Three of the four undergraduates were SPS leaders. Despite our commitment, our team isn’t yet a success story. Our department is understaffed and lacks a single point of contact on this project. Early on, communication broke down and only recently have we started working together again on these goals.

At the beginning of the 2021 spring semester, the SPS leadership, only four strong at the time, decided to take things into our own hands! After some successful virtual game nights an idea hit us: how easy would it be to have an alumni panel over Zoom? We thought an alumni panel could increase students’ sense of belonging through the community-building aspect and contribute to their physics identity by recognizing students as future professionals.



ABOVE: A screenshot from the virtual alumni panel hosted by Bryn Mawr’s SPS chapter. Image courtesy of Samantha Berry.



ABOVE: Bryn Mawr SPS members enjoy a pajama movie night during finals week in the fall of 2021. Photo courtesy of the chapter.

What followed was an amazing virtual event with nine alumni panelists. We started with a general Q&A, then split the panelists between two breakout rooms and allowed participants to ask questions. We tried to acknowledge the diverse career options for physics majors by including a variety of alumni, from a planetarium director to a patent attorney for a lab. The turnout was unexpectedly high. Looking back, we should have made more breakout rooms!

Because of how successful this panel was, our SPS executive board would like to create another virtual alumni event this spring. However, we haven’t forgotten about the TEAM-UP factors we didn’t touch on last year. During the fall 2021 semester we created a weekly Physics Clinic, a four-hour window where any physics student can drop in and ask questions. We’ve also advocated for more transparency by having undergraduate representatives at department meetings. We are planning to build outreach relationships with our local community and the Philadelphia region, along with so much more.

The SPS chapter at Bryn Mawr College has taken on the role of implementing change. First and foremost, we strive to make sure everyone in our department feels welcomed and accepted. We strive to be more inclusive by following the TEAM-UP recommendations and also giving agency to peers, caring about long-term relationships and partnerships, advocating for the legitimization of historically excluded groups, and holding the leadership in our department and administration accountable. //

ABOUT TEAM-UP

The TEAM-UP report highlights long-term systemic issues within physics and astronomy that have contributed to the underrepresentation of African Americans in these fields and actionable recommendations for reversing the trend.

The Time Is Now: Systemic Changes to Increase African Americans with Bachelor’s Degrees in Physics and Astronomy

aip.org/diversity-initiatives/team-up-task-force



SPS Chapters on PROFESSIONAL DEVELOPMENT

- 1: SPS members from the University of North Carolina, Chapel Hill, gather for a virtual lunch to discuss what they're learning at the virtual 2021 APS April Meeting.
- 2: Roanoke College SPS members Adrienne (left) and Rachel (right) at the 2020 Conference for Undergraduate Women in Physics with Dr. Hiba Assi (center).
- 3: Yale University's SPS chapter cohosts a virtual fireside chat with physics Nobel laureate Donna Strickland in fall 2020.
- 4: The University of Florida inducts its inaugural class of Sigma Pi Sigma members. All photos courtesy of the corresponding chapter's 2020–21 chapter report.



Breaking through Barriers in Physics

by Joseph Hall, Taylor Knapp, Jasper Chen, and Isabel Horst, SPS Members, Brown University

ABOVE: Left to right: Isabel Horst, Taylor Knapp, Jasper Chen, Smita Rajan, and Joe Hall. Photo courtesy of the SPS chapter.

As wonderful as physics is, students and professionals alike often face significant challenges. These barriers range from those that can affect us all, such as mental health issues and poor work/life balance, to systems of oppression that specifically target groups historically underrepresented in science. Throughout the pandemic and into the fall 2021 semester, the Brown University SPS chapter has strived to provide balanced academic and social support to our community, with an emphasis on making physics feel more accessible and welcoming.

One way we've supported these goals is by hosting workshops called Barriers in Physics. These events are open to all interested undergraduates and focus on addressing common issues and misconceptions within the physics community.

For a workshop on imposter syndrome—defined by Merriam-Webster as “a false and sometimes crippling belief that one’s successes are the product of luck or fraud rather than skill”—we asked tenured professors to write letters about the doubts and setbacks they faced in their careers and how they overcame them. We were incredibly grateful to have over a dozen senior professors contribute to this event. Consider some of their responses:

“Imposter syndrome for me manifests as that internal voice that attributes

successes to luck or to distraction on the part of others, while replaying failures/mistakes vividly.”

“The kryptonite to imposter syndrome is the courage to face my own ignorance and the willingness to learn whatever I didn’t know before.”

“I immediately thought they chose me because I am a woman and not because I was an expert in the matter, and that I will never measure up to the level of leadership provided by my predecessor.”

“There’s a huge difference between ‘I don’t belong in physics’ and ‘This environment is not a good fit for me.’”

As physics students, our understanding of imposter syndrome was completely transformed by the knowledge that many of our role models have and continue to work through the same fears and anxieties. While imposter syndrome is sadly pervasive, it helped the student participants to realize that others have felt the same way and have been able to go on and succeed.

Another challenge we tried to address in the past year was the prevalent feelings of alienation and loneliness among students due to remote learning. For a workshop on community and belonging, we asked students to reflect on their own feelings, as well as to identify shared

aspects of their experience with others. The event included introductions, a short journaling exercise, and breakout groups in which participants discussed the following questions: Are any of the reasons people might not feel a part of the scientific community unavoidable? What actions can be taken to help others feel like they belong in physics?

We also discussed how losing historical context for scientific discovery, particularly the erasure of female physicists and physicists of color, reinforces the idea that scientific intuition is inborn or related to “talent” rather than something all people are capable of. This mistaken belief was a big reason many participants doubted their abilities early on and considered switching majors.

Physics is plagued by the myth that progress is made by one person, particularly the stereotype of the lone genius at a chalkboard. While some important historical individuals in physics fit this profile, this view is wholly distorted. Scientific progress is built through collaboration, and everyone should be encouraged to contribute. It is important that we, as SPS members, spread the feeling of belonging and build community in physics so we can break down these barriers. Our goal is to continue the work of making the physics community at Brown—and beyond—more welcoming, accessible, and inspiring. //

Presenting on Our Outreach Program

by Sam Williams and Kaleb Martin, SPS Members, Radford University

Last April we gave a professional presentation about our SPS chapter's outreach events for local high school students. The goals of our outreach program were to increase interest in and motivate high school students to pursue STEM by teaching them to build AM radios. We hosted two events via Zoom, one in the fall of 2020 and one in the spring of 2021. Each student received an AM radio kit purchased with funding from an SPS Marsh W. White Award. We learned a lot from these outreach experiences and even more from giving a talk on them to physics educators.

After we completed our outreach events, our SPS advisor, Dr. Rhett Herman, suggested that we present our work at an upcoming meeting of the Chesapeake Section of the American Association of Physics Teachers (CS-AAPT). The meeting was being hosted by our school, Radford University, in April of 2021.

Even though the meeting was virtual, giving a talk was daunting. Several dozen physics teachers from across Delaware, Maryland, Virginia, and the DC



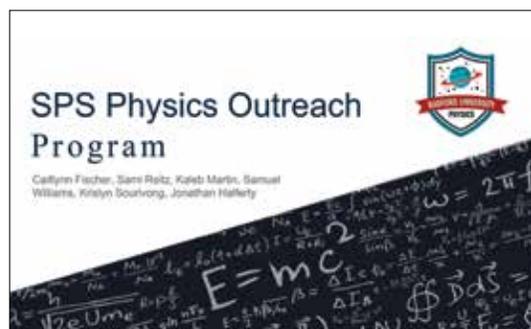
area—plus a few from outside the region—were also presenting. They gave talks on techniques, methodology, and programs to teach physics. Here we were, a group of college students, with all of these professional educators listening intently to what we had to say about outreach. It was the first time many of our members had presented their work in a professional setting.

First-year student Kaleb Martin summed up the experience this way: “When I started speaking I was pretty nervous, but as I kept talking I noticed the butterflies in my stomach left. It was nice to see that other people were actually interested in what we did as a group, and I can't wait to do it again. Overall, I think it was a really cool experience to hear all of the professors [giving talks] and listen to what they did or wanted to improve on.”

Presenting was an insightful experience. After the presentation, several of the educators applauded us for orchestrating our program—they said it was refreshing to see youth teaching youth and breaking down complex subjects in a manner that younger students could digest. They also commented on how much of a feat it was for us to be so young and participating in a presentation of this scale.

Even though the scope of our outreach project wasn't on the same scale as what other educators were presenting, they still respected our work. They were friendly and inviting and urged us to do similar programs in the future. We also shared ideas about branching out and conducting more outreach events over a wider range of topics; they didn't hesitate to encourage us to continue sharing our love of science with younger students.

The thought of presenting our work to a group of professionals was intimidating at first, but the experience was well worth it. We would absolutely recommend that other undergraduate students participate in presentations like this. It was a pinnacle of accomplishment for our chapter. //



ABOVE RIGHT: SPS members (L to R) Sam Williams, Anith Muthalaly, Caitlyn Fischer, and Krislyn Sourivong teach students how to construct radios over Zoom.

ABOVE: Title slide from Radford University's SPS chapter presentation. Images courtesy of Radford University's SPS chapter.

Learn more about the SPS Marsh W. White Award for chapters hosting outreach events at spsnational.org/awards/marsh-white.

Introducing Mental Health Week



by Sean Tobin, SPS Chapter President, The Pennsylvania State University

Exams, research deadlines, meetings, homework . . . college is stressful. Juggling all of my obligations while maintaining a healthy social life and setting aside time for myself gets tougher every week, as more responsibilities pile up. And that's not to mention the innumerable stresses that COVID-19 added to the mix. When my stress level gets too high, it poisons my mental health.

My experience isn't unique. That's why the Penn State SPS chapter created Mental Health Week—to offer a lifeboat to members struggling with mental health issues.

We held Mental Health Week the week before spring finals, the most stressful week of the semester. Each day we showcased an on-campus resource or featured a stress-relieving activity. Our event list included a virtual social, a talk on imposter syndrome and dealing with failure, a panel on diversity and mental health as it relates to minorities in STEM, a yoga session, and a painting interlude.

These events helped our members recoup and recharge. The social brought people together during another difficult COVID-19 semester, reminding everyone that we are in this together. The talks were informative and provided tools for supporting each other and encouraging empathy. The yoga session offered an island of calm in a turbulent sea. Painting, the last of our events, helped us destress and decompress so that we had our heads on straight going into finals.

Those who participated in our inaugural Mental Health Week came away feeling refreshed and better able to care for themselves, and we considered that success. As a chapter, we think it's important to reach out to people who may be feeling isolated and bring everyone together; embracing and supporting our vulnerabilities makes us better physicists and better people.

I encourage you and your chapter to consider organizing a Mental Health Week. I recommend including events that allow the community to come together and relax, educate members on the mental health resources available on campus, provide a safe and calm space away from stressors, and promote inclusion. Most importantly, be sure to have fun.

Mental health is something that we all have to protect. Taking care of ourselves and supporting each other is—and will continue to be—key as we become the next generation of scientists. //



ALL: Penn State SPS members enjoy in-person, relaxing outings during the fall of 2021. Photos courtesy of the chapter.

Transforming Pizza Lectures into Virtual Visits

by Ruth Malenda, SPS Chapter Advisor, Emma Miller, SPS Chapter President, and Cecilia Zimmerli, SPS Chapter Vice President, Moravian University



ABOVE: Moravian University SPS members pose for a group photo. Photo courtesy of the chapter.

The Moravian University SPS chapter has been hosting Pizza Lectures for decades—literally. According to Dr. Edward Roeder, who retired last year after 55 years of teaching physics, these informal talks with a side of free pizza began in 1985.

Over the years, guest speakers for this series have included chapter members with research or internship experience, graduate students, and professional scientists from places such as NASA, Bell Labs, and Oak Ridge National Laboratory. The talks give our members insight into different types of research, models for presenting their own research, and an opportunity to ask questions about graduate school or careers in physics. Plus—free pizza!

But last year was different; like so many other aspects of college life, when COVID-19 hit, these valuable events couldn't continue in their usual form. So we reinvented Pizza Lectures as Virtual Alumni Visits. Alumni were invited to come back—virtually—and update us on their lives since graduating. We asked presenters to answer a short list of questions

such as, “Do you have any advice for undergraduate students postgraduation?” and “What do you wish you had done differently or learned at Moravian?” But most of the time was reserved for attendees to ask questions.

In the fall semester, we hosted Katie Bahnck and Bryan Harvey. Katie graduated from Moravian in 2018. At the time of her virtual visit, she was finishing up a master's degree in mechanical engineering at Washington University in St. Louis. Bryan graduated in 2019 and is a physics PhD candidate at Texas A&M University simulating nuclear collisions.

Alumni Fouad Haddad and Matthew Connors were guest speakers in the spring semester. Fouad graduated from Moravian in 2018 and earned a master's in energy engineering from Lehigh University. He's now an aerospace and mechanical engineering PhD candidate at the University of Arizona. Matthew graduated in 2019 and is an associate engineer in the facilities engineering department at a medical device company.

The Virtual Alumni Visits provided valuable opportunities for undergraduate students to ask alumni questions about their postgraduation experiences and get advice on how to make the most of their time in college. Emma Miller, senior physics and mathematics major and current SPS chapter president, says that the talks were “a good first look into what grad school is like, as well as other potential options for after graduation.” The guests enjoyed sharing their experiences with current students and reconnecting with familiar faces among the faculty and students who attended.

The world has changed dramatically over the past two years, and connecting with others has become more important than ever. Thanks to the flexibility, adaptability, and ingenuity of club members and the technological advances of remote conferencing, our SPS chapter found a way to persevere, strengthening relationships and connecting across the challenges of COVID-19. Even without free pizza. //

Need help finding physics alumni to participate in your chapter meeting or event? Connect with Sigma Pi Sigma members and SPS alumni through the Alumni Engagement Program—a database of participants who are willing to be speakers or panelists (in-person or virtual), tour guides, and mentors. spsnational.org/programs/alumni-engagement

Ideas Worth Stealing



Duke University:

To stay engaged with our community of alumni, every year we collect contact information and postgraduation plans from graduating seniors via a Google form. The responses are accessible to current members for networking or mentorship purposes.



University of North Carolina at Asheville:

Our chapter made it a goal to become more involved in department retention. Every time a new student declares a physics or astronomy major or minor, the department chair or the student's advisor now sends an email introducing them to SPS. We then add them to our mailing list and invite them to upcoming events. We've seen a significant number of people we've reached out to in this way become part of SPS.



University of Washington Bothell:

Campus life suffered during the pandemic, but our SPS chapter was determined to stay connected. SPS exists to encourage interest in physics among students at all levels, and we took this intention to heart. We decided we needed a social media and marketing officer, so we advertised the position to marketing majors and welcomed a candidate to our team. We also created our first ever weekly newsletter. In addition to promoting events and campus resources, we featured club members and highlighted faculty and nonphysics students. Over the course of the year our chapter grew from 15 to 70 members, with many joining us from across a variety of different degree programs.



ABOVE: A preview of one of the University of Washington Bothell SPS chapter's weekly newsletters.

..... Quirky and Creative



University of Northern Iowa:

During the summer of 2020, we helped run a virtual summer camp for elementary school students called Beyond Frozen: The Science, Math, and Art of Fractals. Attendees spent a week learning about fractals and creating physical and digital fractal art. They also found fractals in nature and submitted photos to an online fractal gallery.



Luther College:

One of the ways we maintained a sense of community this year was through our physics T-shirt design contest. Each fall members submit ideas, and in spring we finalize the designs and vote. This year the two runners-up included a cat composed entirely of equations and a funny test filled with inside jokes from the department. The winner, by a large margin, featured an integral showing that the expectation value of the Spanish Inquisition is zero (because, according to Monty Python, no one expects the Spanish Inquisition). The design owed its success to the impassioned lobbying of a few senior members who had seen the design fail to win over the previous three years. We even extended apparel orders to Luther physics alumni, many of whom were supporters of the design.

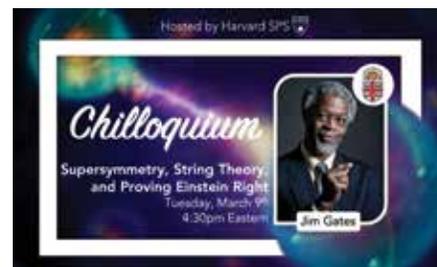
$$\int_{-\infty}^{\infty} \psi^* \left(\text{Three Inquisitors} \right) \psi dx = 0$$

LEFT: The winning design of this year's T-shirt contest, showing that the expectation value of the Spanish Inquisition is zero.



University of Maryland (UMD) & Harvard University:

In the fall of 2020, our SPS chapter at UMD was invited by Harvard SPS to participate in their undergraduate "Chilloquium" series. We eagerly accepted. These weekly talks introduced prominent physicists as people, presenting their work at a level accessible to undergraduates.



ABOVE: A flyer for a Chilloquium talk featuring Dr. Jim Gates.

Wow!



Howard University:

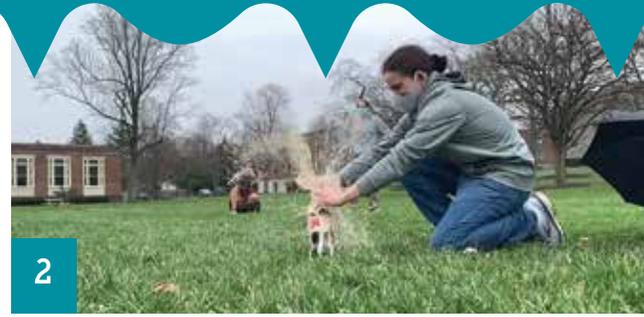
Along with a friend, SPS member Christina McBean collected and distributed Amazon Fire tablets to students in rural areas of Jamaica to use for online learning.



LEFT: Students from the community of Burnt Savannah in Westmoreland, Jamaica, pose with tablets that will be used for online learning. Photos and images are courtesy of the corresponding chapter.



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SPS Chapters on HANDS-ON PROJECTS

1: Members of the Reed College SPS chapter during a socially distanced egg-launching competition that made good use of the department slingshot.

2: Members of the SUNY New Paltz SPS chapter (explosively) show off the reaction between Mentos and Diet Coke.

3: The Southwestern Oklahoma State University Physics Club prepares a rocket for launch in the Argonia Cup Rocketry Competition in Argonia, Kansas, in March 2021. The club earned second place.

4: Members of the University of Nebraska-Lincoln SPS chapter prepare for a high-altitude balloon launch. All photos courtesy of the corresponding chapter's 2020–21 chapter report.

From Leonardo to NASA and Back Again

by Austin Bridwell, SPS Member, McMurry University

They say good things take time, so the best things are finished last minute.

It was moments before the unveiling of the Leonardo da Vinci helicopter at our Sigma Pi Sigma chapter's new member induction, and the final touches were being applied. Several of us were crowded around a three-foot box, stuffing in wiring and ensuring the connections to the motor were making good contact. We had started our project in the fall of 2020, but, due to a virus we all know and do not love, our true start date was the spring of 2021.

Shortly after starting the helicopter project (the first time), our SPS advisors stumbled across a NASA program aimed at assisting the Artemis mission, which will send the first woman and next man to the moon to conduct research and aid in the future exploration of Mars. The program, called MINDS—Minority University Research and Education Project (MUREP) Innovative New Designs for Space (MINDS)—challenges undergraduate students and their faculty with designing and building technologies for the mission.

Our department's class on the solar system had already created a proposal for a class project on electric charge mitigation on the shadowed side of the moon, so it was fitting for our SPS chapter to use this proposal to jumpstart a NASA MINDS project.



With this project we intended to find a solution for dissipating built-up static charge in lunar soil on the shadowy regions of the moon during the Artemis mission. Lunar soil is a jagged, crystalline structure. If statically charged it can cling to equipment, and if inhaled by humans it can lead to respiratory issues and increase the risk of cancer. The main objective of the project was to ensure astronaut safety. The task was difficult and required all hands on deck.

We collaborated with students in the solar systems class, although several of the volunteers had no expertise on the topic, just personal interest and a willingness to help. The most challenging aspect was creating a vacuum of approximately 170 millitorr to emulate the lunar environment.



But as with most research undertakings, our challenges weren't limited to just one aspect of that project. We experimented with a variety of possible solutions to meet an array of obstacles. Our final results, which we submitted to NASA, determined that the best way to keep static charge from accumulating on an astronaut's suit was to attach a flexible conductive fabric to its exterior.

After wrapping up the MINDS project, we turned back to our scaled model of a helicopter based on Leonardo's historic design. As we

watched the helicopter spin during the Sigma Pi Sigma induction, we felt a great sense of accomplishment. The two projects taught us how to look at problems from multiple angles, resolve challenges, implement solutions, and stick to a tight schedule. Our SPS chapter grew closer, and we gained experience applying what we've learned in the classroom. One of our graduating team members even went on to work for NASA!

Now that we've finished these two major undertakings, we're excitedly searching for our next new challenge . . . //



LEFT: A view of the NASA MINDS project setup. Photo courtesy of the chapter.

MIDDLE: Jacob Williams discusses using a small craft model of Leonardo da Vinci's helicopter as the basis for a larger scale model. Photo courtesy of the McMurry Advancement Office.

ABOVE: Joseph Watson fits the freshly cut canvas helicopter "blades" to the model. Photo courtesy of the McMurry Advancement Office.



From Brainstorming to Building a Satellite for Space

by Benjamin Wilson, SPS Member, Rhodes College

Have you ever wondered what it would be like to build a satellite without the support of an engineering program? Well, that's what the Rhodes College CubeSat team is doing! Utilizing our team's various skills, we're putting together a CubeSat that will eventually launch into space aboard a NASA rocket.

CubeSats are four-inch-cube satellites that test developmental technology in space. They're becoming increasingly popular, as their small size and relatively low cost have made space more accessible to smaller research teams and institutions.

Our mission, dubbed RHOK-SAT, is a collaboration between Rhodes College and the University of Oklahoma. The mission's educational objective is to provide a technology-intensive experience for students attending a liberal arts institution, which describes our team at Rhodes. Its scientific objective is to test the space hardness of perovskite solar cells. That's where the University of Oklahoma comes in. RHOK-SAT will be one of the first missions to

test solar cells of this type. We hope to show that they are viable candidates for powering future space missions.

There are about ten students on the Rhodes team, with additional students planning to join this spring. Most are physics and computer science majors, and all of the physics majors are part of SPS.

THINKING BIG

As undergraduate students with limited technical knowledge, the idea of building a satellite seemed far-fetched at first. Friends didn't even believe us when we first told them our goal!

We decided to build a CubeSat in 2019, after our department received a financial gift to support research. Our first question was, "Where do we start?" We began by brainstorming a mission. We considered everything from space debris detection to deforestation tracking. After some time we met the Photovoltaic Materials and Devices Group at the University of Oklahoma and heard about their solar cell

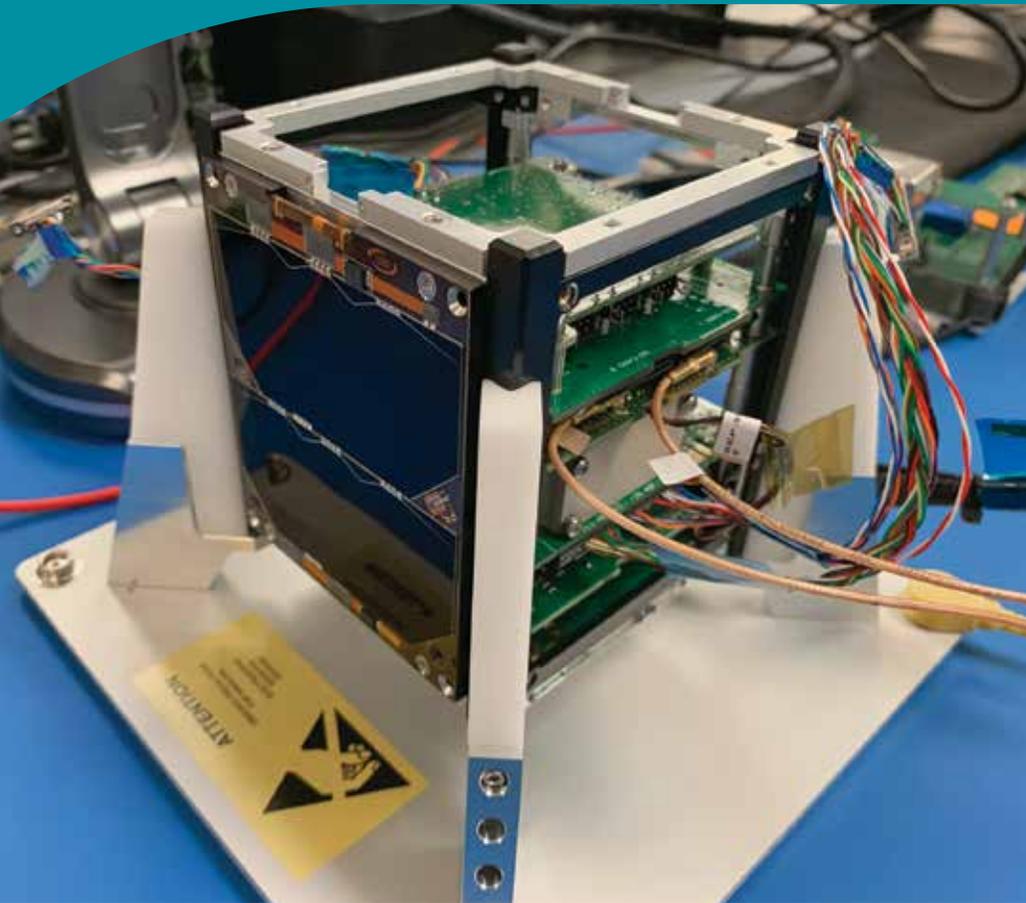
research. We decided to work with them to test novel solar cell technology and its potential to power future space missions.

After deciding on a mission, our next task was simple. Build a satellite.

EYES AND EARS TO THE SKY

Over the summer of 2020, our team members worked on the project from home. We learned how radio antennas work, how satellites are tracked in orbit, and how to program micro-controllers for solar cell data acquisition. Using satellite tracking software and homemade antennas, we stood on our roofs and listened to satellites passing overhead. In order to communicate with our satellite by radio, we needed to get HAM radio operator's licenses. We've since constructed our own ground station on campus to talk with the satellite.

In fall 2020 we submitted a proposal for consideration by NASA's CubeSat Launch Initiative (CSLI). The initiative provides universities, high schools, and nonprofit organizations



FAR LEFT: Rhodes CubeSat team members at work. From left to right: Professor Ann Viano, Benjamin Wilson, Giuliana Hofheins, and Olivia Kaufmann. Photo by Ethan van Drimmelen.

LEFT: An engineering model of the satellite used for development and testing. Photo courtesy of the Rhodes CubeSat team.

with the opportunity to fly a small satellite payload on an upcoming launch. With the help of advisors and reviewers from various scientific backgrounds, we outlined our project and its relevance to the scientific community. In April 2021, RHOK-SAT was one of 14 small research satellites selected! This means RHOK-SAT will be launched by NASA on a rocket as an auxiliary payload, and NASA will cover all or most of the launch costs.

Our CubeSat will likely be in the cargo of a resupply or crew launch to the International Space Station (ISS), along with other CubeSats. Astronauts aboard the ISS will load the satellites into a launch tube and deploy them into orbit. Not all CubeSats are launched this way, however. Satellites that require specific orbit parameters, such as height above Earth or angle of flight relative to the equator, can be jettisoned directly from a rocket as it's in the desired orbit.

BUILDING FOR SPACE

Teams that build satellites start by testing their ideas on an engineering model (EM) that does not go into space. Our EM is a replica of the satellite and we use it for hardware and software development. The EM also helps us test software updates before we send them up to space.

Our programming team is working with the EM to write custom flight software. This software ensures the correct operation of the satellite's subsystems, collects data on the solar cells, and reports everything back to us on the ground. Each solar cell's data is collected through a dedicated microcontroller. The on-board computer will run on a real-time operating system (RTOS). The RTOS runs normal operations, executes tests on the solar cells, and controls radio communications. If the system encounters a bug or malfunction,

the RTOS can recognize it, stop the current command, and alert us before more problems arise.

As one of the first teams to send these solar cells into space, we're facing new engineering challenges. As a result, we've learned how to design, print, and test custom hardware using 3D design software and 3D printers. To electrically connect to our test solar cells, we've designed printed circuit boards to fit exact specifications.

One of our current projects is sun sensor calibration. We only want to take solar cell measurements when the cells are pointing toward the sun, so we're using a photodiode to track the angle between the sun and the satellite.

We're also working on educational outreach. As part of our educational mission, we hope to spark interest in STEM fields among high school students. So we visit local high schools in Memphis, Tennessee, to teach them about our project, solar technology, and the effects of gravity in space.

We are about halfway through the project and aim to be ready for launch by June 2023. While we still have much to do, our experience so far has been priceless. We will be forever grateful for this opportunity and the connections we've made along the way. These experiences have challenged our perception of what's possible—even if you don't have an engineering department at your disposal. //

GET MONEY FOR CHAPTER RESEARCH!

Rhodes College has received multiple SPS Chapter Research Awards to help support this project. SPS Chapter Research Awards financially support chapter research activities that are imaginative and likely to strengthen the SPS program. The awards of up to \$2,000 are generously funded by donations from Sigma Pi Sigma members and friends of SPS. Applications are due November 15 each year. spsnational.org/awards/chapter-research

Magic Flickers in the Darkness



by Eileen Wilcox, SPS Member, and Adam Lark, Assistant Professor of Instruction and Director of the Peters Observatory, Hamilton College

On a dark, lonely hill at Hamilton College, magic flickers in the darkness. One year ago the college's secluded solar classroom resembled an overstuffed storage unit. SPS member Leenie Wilcox saw an opportunity to revitalize the space, and with the help of Professor Adam Lark, she converted the classroom into a museum and art installation.

The deep-blue walls have transformed into maps of the heavens and their constellations. Thousands of stars stretch across the ceiling to form the Milky Way. The shelves are lined with treasures. Hundred-year-old textbooks on mathematics and optics exhibit woodcut diagrams. Optical tubes with trap doors for film cartridges preach of a grittier era in astronomy. Hand-crafted telescopes draw in marveling eyes.

Beauty, however, was not the only goal of the project. The room was designed to inspire. To marry art and science in their shared goal

of revealing the complexity of the universe and one's small place in it. To divorce the human experience from clutter and to view the world with clarity.

As a creative solution for outdoor events in the COVID era, Hamilton's SPS chapter held numerous Observatory Nights. Individuals from all corners of campus gathered to see the stars and view the solar classroom. Students apprehensive and uncomfortable in a science classroom found themselves beside physics students. Between moments of awe—when eyes were drawn upward through telescopes, paintings, and open skies—barriers wilted as conversations and friendships blossomed. It is impossible to know what might inspire or direct a student's life, but bringing physics into the realm of approachable curiosity may open minds to what is possible with science. //

TOP: Students visit the solar classroom at Hamilton College, which an SPS member turned into a museum and art installation. During Observatory Nights, individuals from all corners of campus gathered to see the stars and view the classroom. Pictured are Grace Godwin (left) and Eileen Wilcox (right). Photo courtesy of Samantha D'angelo.

Cardboard Regatta Champions (Again)

by Oscar Peterson-Veatch, SPS Chapter President, Augustana College

During Augustana College's homecoming week, several competitions are held between the student organizations. Our SPS chapter, the Augustana Physics and Engineering Society (A.P.E.S.), traditionally participates in just one of these competitions—the Cardboard Boat Regatta. We were thrilled to take home the championship again in 2021!

In the fall of 2017, members of A.P.E.S. decided to design a cardboard boat with greater longevity—one that the club would be able to use for years to come. After we agreed on a design, several hours over the span of a month were spent constructing the boat using only cardboard, duct tape, and contact cement. The base is the strongest part of the design, ensuring no water can enter the boat.

We continued to refine the design and eventually constructed the boat pictured. We're proud to say that A.P.E.S. has won the Cardboard Boat Regatta each year since we began entering this design! We enjoy showing off a little every year, as ours is the only boat that has endured through multiple years of races.

The Augustana Cardboard Boat Regatta is a really great way for our club members and the members of other student organizations to come together and have some fun. We are proud of what we were able to build together! //



ABOVE: Members of Augustana College's SPS chapter, known as the Physics and Engineering Society (A.P.E.S.), celebrate taking first place in the 2021 Regatta. Photo courtesy of the chapter.

Bringing Back the Fun

by Shalauni Patel, SPS Chapter Co-President, Adelphi University



ABOVE: SPS members celebrate with Dante (center) after his egg survived the drop. Photo courtesy of Matt Wright.

“That was so cool!” says almost every student after a thrilling physics experiment. I think I speak for all when I say that students get tired of doing grueling calculation after calculation, and at that point, physics becomes more of a task than a passion. However, when we do even a small fun experiment, our passion for physics usually returns.

Physics is part of our everyday life even when we aren't paying attention. But it's extremely energizing (no pun intended) to see calculations and equations come to life. In an attempt to catch sight of these everyday physics encounters, students in the Adelphi physics department have been doing a lot more experiments and hands-on activities lately, primarily just for fun.

It's become sort of a tradition within our chapter to hold an annual egg drop. In teams of two and with a limited amount of time and materials, we build small contraptions to keep raw eggs safe. Then we test our devices by dropping them from various heights. Sounds pretty impossible right? Wrong. One of the devices kept an egg safe during a 30-foot drop! Crazy! Imagine what we could do with additional supplies and more time! The possibilities are endless.

We also do a Lab4Kids outreach event every year, which has been one of my favorite experiences so far. This is an opportunity to share our love and appreciation for physics with local high school students and encourage them to consider physics as a career option. We do many fun experiments and activities, such as play with an angular momentum wheel, build small DC motors, experiment with optical colors, demonstrate holograms, and much more. Students are also able to tour our physics labs to learn what we do outside of lectures.

It's very refreshing to take a break from quantum calculations to share some exciting physics with the younger folks or test out physics for ourselves. Experiences like these really bring out the physics from textbooks in a fun way. After all, physics is about having fun! And doing some equations... //



SPS Chapters on OUTREACH

1: Rhodes College's SPS chapter hosted a physics photo contest open to college students, local public schools, and students from the Refugee Empowerment Program. "Popping in and out – Quantum Foam" by Duc Hoang was awarded first place at the college level.

2: Serenity Engel, SPS chapter president at South Dakota School of Mines and Technology, introduces students to SPS at the 2020 campus organization fair. Photo courtesy of Serenity Engel.

3: Denison University's SPS chapter secretary, Jaelyn Roth, performs a liquid nitrogen demonstration during an outreach event held over Zoom.

4: University of Alaska Fairbanks physics professor David Newman demonstrates quantum levitation to SPS members with a piece of yttrium-barium-copper oxide.

5: The University of Virginia's SPS chapter works on an outreach video to share with elementary school students. All photos courtesy of the corresponding chapter's 2020–21 chapter report unless otherwise noted.

When the COVID-19 pandemic started surging, life as we knew it was drastically altered in several ways. Of all the things that changed for our SPS chapter at University of the Sciences, one of the most prominent was our plan for sharing science with the community. We had intended to host an in-person outreach event, as we have many times in the past, but it became clear that we would have to make some adjustments.

In this age of technology, we decided that the best course of action was to do outreach over Zoom. The questions then became, “Who do we reach out to?” and “How do we make it as interactive and effective as our in-person events?”

We chose a thermodynamics theme—What’s so hot with physics?—and decided to host the event jointly with Puratos Corporation, a Belgian multinational food company with a local presence in New Jersey. Puratos is a long-standing partner of the Physics Wonder Girls Program, a STEM camp we host on campus each summer.

Our target audience was high school students from the collective Philadelphia and Southern New Jersey region. Our chapter advisor, Dr. Roberto Ramos, reached out to the Philadelphia STEM Equity Collective and advertised our program to its 400+ member STEM Ecosystem, consisting of local schools, universities, and nonprofit organizations.

Our lineup included thermodynamic demonstrations along with a plant tour and women-in-STEM forum hosted by Puratos Corporation. These additions gave it a unique twist and showed attendees that STEM plays a surprising role in food manufacturing.

To keep students interested in our virtual demos, we made some modifications. We switched out some of our usual demo gear for homemade versions, illuminating how physics can be seen in everyday life and showing attendees how to follow along and do experiments with us.

We had over 200 attendees! Our demos were a big hit, and not only with the students in the audience—they left a lasting impression on all of the SPS members as well. Fan favorites included hand boilers, ice melting blocks, and liquid crystal sheets!

A Virtual Take on What’s Hot in Physics

by Dan Fauni, SPS Chapter Vice President, and Ryan Hess, SPS Chapter Treasurer, University of the Sciences



■ ABOVE: The SPS chapter at University of the Sciences. Photo courtesy of the chapter.

Nell Grabowski, our SPS chapter president, says the event was “an eye-opening experience of the future of physics.” SPS chapter secretary Ryan Hess thinks it had a much greater impact than previous outreach activities because of the unique format. He especially liked that students had the option to do experiments at home alongside the presenters. “It was the first time I could personally see the excitement in students’ eyes,” he says.

Our chapter is extremely proud of this outreach event and its reach. The circumstances of COVID-19 were bleak, but they didn’t stop our SPS chapter from carrying this project forward. Even when the world feels dark, we can make a change for the better. //

GET MONEY FOR CHAPTER OUTREACH!

University of the Sciences received an SPS Future Faces of Physics Award to help support this project. SPS Future Faces of Physics Awards support projects designed to promote physics across cultures. The awards of up to \$500 are generously funded by donations from Sigma Pi Sigma members and friends of SPS. Applications are due November 15 each year.

spsnational.org/awards/future-faces

Virtual Demos Maintain—and Broaden—Community Outreach

by the SPS Chapter at Texas A&M University-Commerce

Every semester the Department of Physics and Astronomy and SPS chapter at Texas A&M University-Commerce (A&M-Commerce) host a Physics Day event for local high school students and teachers. Due to the COVID-19 pandemic, in 2020 our chapter spent a few weeks creating videos while following local and CDC guidelines, which allowed us to provide virtual outreach activities when in-person meetings were not possible. We recorded videos of students presenting physics demos, sharing their research and teaching experiences, and leading virtual lab tours. In the spring of 2021 we recorded a virtual panel addressing questions that local high school students sent in about college life and the life of a physics major at A&M-Commerce. We've since shared all of these videos with students and teachers. We also presented at the 2021 Dallas ISD STEM EXPO virtual event and were able to reach an even wider audience. You can check out the videos on our SPS chapter's YouTube channel at short-url.at/lwENW. //



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4

1: Miranda Martinez shares her research on x-ray photoelectron spectroscopy as part of the Surface Science Lab at A&M-Commerce.

2 & 3: A&M-Commerce SPS president Keely Scott (left) and vice president Madison Smith perform demonstrations with liquid nitrogen (2) and circuits (3).

4: A&M-Commerce student Elijah Prince (left) and SPS member Jake Richter provide a virtual tour of a semiconductor physics lab and share their undergraduate research experience. All images courtesy of the chapter.

Additional officers, students, and faculty featured in the videos include James Hirons, Zorayda Martinez, Flint Morgan, Jacob Ward, Ian Jimenez, Michaela Allen, Dr. Anil Chourasia, and Dr. Heungman Park.

Demonstrating Wastewater Remediation with Solar Technology

by Sessa S. Srinivasan, SPS Chapter Advisor, Daniil Ivannikov, SPS Chapter President, and Scott L. Wallen, Research Mentor, Florida Polytechnic University

The engineering physics (EP) degree program at Florida Polytechnic University launched very recently, in 2019, although we've had an SPS chapter since 2015. Daniil Ivannikov from Key West, Florida is one of the first EP students and the current chapter president. He has had a passion for researching and developing sustainable technologies from day one. Last year he studied using solar photocatalytic advanced oxidation to treat wastewater.

In his research, Daniil developed a low-cost procedure to synthesize modified photocatalysts that, under solar irradiation, can quickly degrade organic contaminants in wastewater. He did this under the supervision of Drs. Sessa Srinivasan and Scott Wallen. Our SPS chapter then set up an outdoor demonstration of this process with funding from the Hinkley Center for Solid and Hazardous Waste Management.

One fine, sunny day, Daniil and other SPS members from the FL Poly chapter assembled a batch reactor near our campus pond. Using natural sunlight and the modified photocatalysts, we demonstrated remediation of the pond water.

This event was sponsored by the Florida Polytechnics Marketing and Communication Department (University Relations) and the Admissions Department to promote undergraduate research to prospective and current students. We'll share video of the demonstration with students during the STEM events our SPS chapter hosts for middle and high school students in the local underserved community of Polk County.

By extending this research project to include an outreach aspect, we hope to attract many new students to engineering physics and to increase interest in STEM more generally.

This project was funded by an SPS Award, Hinkley Center for Solid and Hazardous Management, and the Florida Industrial and Phosphate Research Institute. //



1

1: SPS members and a local middle school student set up a batch reactor near FL Poly's pond to treat wastewater. In the background is the campus' state-of-the-art Innovation, Science, and Technology Building, surrounded by pond water.



2

2: Students collect FL Poly pond water samples for the sunlight-assisted photocatalytic treatment.



3

3: SPS faculty advisor Professor Sessa Srinivasan (right) supports the students in setting up the solar photocatalytic reactor at the FL Poly pond water site.



4

4: Students work on batch reactor setup and calibration measurements. SPS president Daniil Ivannikov (left) is assisting and training other students. All photos courtesy of Florida Poly - University Relations.



1

Spooky Physics for Curious Students

by Jet Rostykus and Portia Allen, SPS Members, Colorado School of Mines

On the eve of Halloween, as the haunted day crawls ever closer . . . in a chilly atrium, cool and clear . . . cauldrons bubble, mist rolls across the floor, and lab-coat-wearing figures scurry about, preparing for the coming chaos. As the sun rises ever higher, the figures finish their preparations and children in monstrous costumes trickle in, guided by their patient guardians.

This is the Haunted Physics Lab (HPL), an annual outreach event for K-8 students hosted by the Colorado School of Mines SPS chapter. Here, young students experience physics through a spooky collection of science demonstrations and collect tasty treats along the way. We hope to help inspire the next generation of scientific thinkers and get attendees engaged in the wonderful world of STEM.

As students first walk in the door, they are greeted by a loud crackle as aluminum cans collapse from the unseen power of air pressure, under the guidance of SPS officer Keenan Myers. For students who have never considered the atmosphere around them to be anything more than empty space, this is an eye-opening experience and an exciting introduction to the scientific mysteries of the world around them. At other stations, students play with non-Newtonian fluids, dance with a robotic spider, and make pretty electric field patterns, among other fun and spooky experiments.

Throughout the day, SPS members Josh Barbell and PJ Olmsted beckon students over to a table in the corner where they can gawk at



1: Colorado School of Mines president Paul C. Johnson, a.k.a. PCJ, joins our SPS volunteers for a group picture.

2: Connor Hewson breaks a cinder block on Dr. Kuo's chest, demonstrating the fundamental physics principles of pressure and Newton's third law.

3: Josh Barbell and PJ Olmsted demonstrate magnetic flux locking by holding a suspended superconducting disk upside down.

4: Keenan Myers shows students how to crush an aluminum can using the pressure of our atmosphere and changing temperatures. Photos courtesy of the chapter.

magical floating metals. Using the power of liquid nitrogen and under the supervision of our very capable volunteers, superconducting ceramic disks chase each other around a magnetic track and “glue” themselves to a metal bar. This invisible connection remains even when the bar is moved in all directions, and even when other materials are put in between the disk and the bar!

Young attendees aren't the only ones who gain from watching—parents and even other Mines students engage with physics during the event. Barbell's favorite part is “being able to introduce many people of all ages to really interesting physics concepts through demos that at first glance seem impossible.”

Our most exciting demonstration is always the bed of nails. One of our officers, Connor Hewson, shows how sharp the nails are by dropping an apple onto them from shoulder height; a murmur travels through the crowd as the apple is violently impaled. The first volunteer is our chapter advisor Dr. Chuck Stone, who lays down and is quite vocal about the sharpness of the nails. After placing a cinder block squarely on Dr. Stone's chest, Connor hefts a sledgehammer and asks the crowd to count down from three. The crowd shouts “Three! Two! One!” as Connor swings the sledgehammer and the cinderblock shatters.

After a few stunned seconds, Dr. Stone carefully sits up from the bed of nails, brushing off dust and completely unscathed. The assistant head of our physics department, Dr. Hsia-Po Kuo, also graciously volunteers for this demo.

At Mines, we are lucky to have a collegiate community that is supportive of our outreach efforts. We often partner with other groups on campus, such as the Society of Women in Physics, Sigma Pi Sigma, and Teach@Mines. The physics faculty and the larger Mines administration encourage our endeavors and go out of their way to participate. The president of Mines, affectionately known as PCJ, even made time between hosting alumni and going to a football game to visit HPL and volunteer for our bed-of-nails demonstration.

After experiencing the nails for himself, PCJ is perfectly fine but plays along with Dr. Stone's drama, praising the spookiness of physics for keeping him safe. Afterward he notes that “SPS has done a fantastic job with the Haunted Physics Lab, and it's great that it is a very successful annual event,” then he asks us to save him a piece of the shattered cinderblock to put in his office as a memento.

As can be expected, putting on this event is no easy task, especially with concerns brought on by COVID-19. This year, as both an in-person event and a virtual livestream, we aim to be more accessible than before and reconnect our SPS chapter to the greater community that we serve. Additionally, we network with members of our community toward establishing future outreach and volunteering opportunities as a way to give back and inspire others to get involved in STEM.

Of course, the best part of HPL is the huge smiles of the young students and their newfound excitement about physics. One of our officers, Paul Varosy, remarks that he loves “watching kids have ‘aha’ moments after interacting with our demos. These revelations are my favorite part about physics, and bringing these experiences to younger students is fantastic.”

As students on our own journey to understand the world around us, we often have similar “aha” moments at new frontiers in physics. Stepping back to facilitate those for others who are just starting their exploration into science is a powerful experience that reminds us what it's like to be full of wonder. Our SPS chapter highly values renewing our own joy in learning through events like HPL, and we are looking forward to more physics outreach in the future! //

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