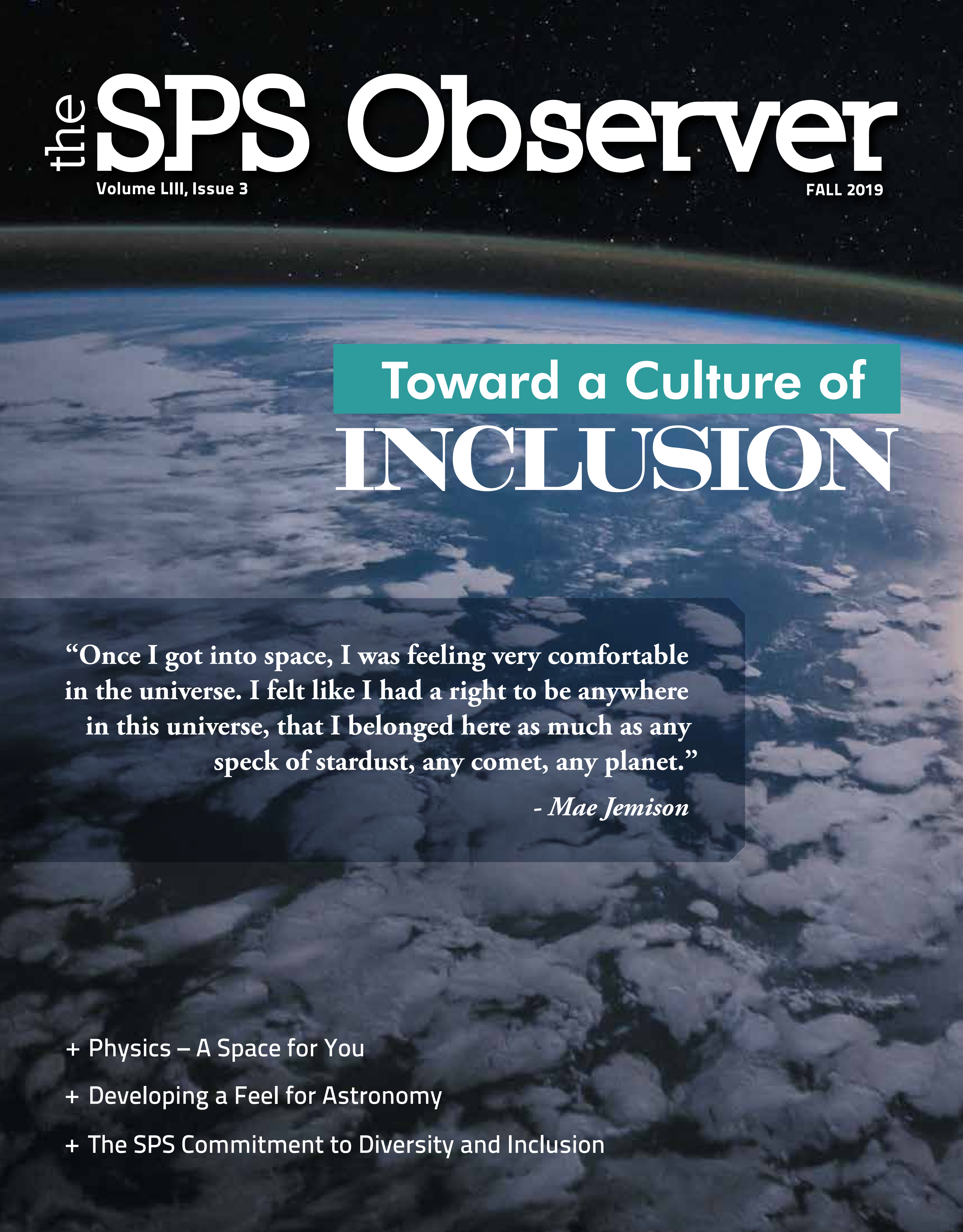

the SPS Observer

Volume LIII, Issue 3
FALL 2019

Toward a Culture of INCLUSION

"Once I got into space, I was feeling very comfortable in the universe. I felt like I had a right to be anywhere in this universe, that I belonged here as much as any speck of stardust, any comet, any planet."

- Mae Jemison

the SPS Observer

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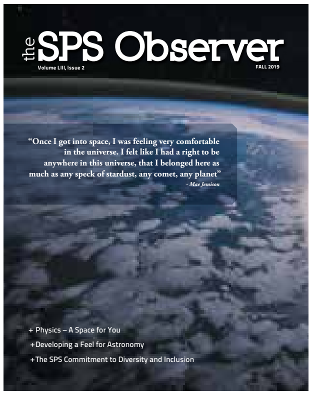

ON THE COVER
A waning sun splayed its light across the planet and created this serene scene. US astronauts aboard the International Space Station snapped this Earth observation on March 2, 2015. Photo by Samantha Cristoforetti, courtesy of NASA.

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Physics for All

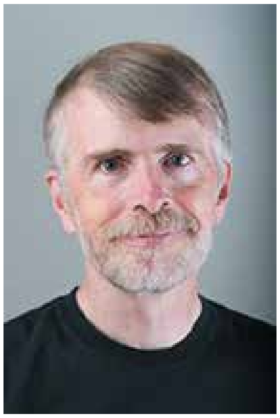
by Earl Blodgett, SPS National Executive Committee, Historian

Is the physics community a reasonable reflection of society at large? Do we as physicists play a role in how welcoming our community is perceived to be by different groups of people? How can we be agents of change within our community and the broader society?

The Society of Physics Students was founded in 1968, a turbulent year in the United States. One would think that an organization launched in the atmosphere of the struggle for civil rights would be attuned to the times. Indeed, the official stance of SPS has always been that of being an organization open to anyone interested in physics, no matter what their background. However, as a group dominated by white males, it was years before the scope of the problem of demographic diversity was really acknowledged and grappled with at the National Council level. Dr. Hla Shwe of East Stroudsburg State College was the first Asian president of SPS, elected in 1977. From the founding of SPS, women were welcome as members within Sigma Pi Sigma and were elected to the SPS National Council even in the early years, but it wasn't until 1991 that a woman was elected president of SPS—Dr. Jean Krisch of the University of Michigan. She was also the first woman elected president of Sigma Pi Sigma, in 1994.

This trend of working to represent everyone that calls themselves a physicist or astronomer has continued—and we've tried to pick up the pace! Over the last 20 years, the SPS Council, the elected body responsible for representing chapters and members at the national level, has typically had a higher proportion of women than one would expect based on the proportion of women in physics, with the fluctuations one might expect given the sample size. Over the years, the council has issued three statements on diversity and inclusion and created programs, awards, and workshops based on the goal of supporting people from groups that are underrepresented in physics, providing good leadership in these areas.

But inclusivity in physics is something that really starts at the chapter level, with individual people *choosing* to make a difference. Grand statements by leaders just don't make a difference if local chapters don't take up the challenge themselves. Look at your own chapter. If you have a commons room where your physics students can hang out, is it *really* a place that is welcoming to all? If your lounge has the social ambience of an eighth-grade boy's locker room, it really isn't going to be a welcoming place for all. (Hopefully it doesn't *smell* like a locker room!)



ABOVE: Earl Blodgett. Photo courtesy of SPS National Office.

Blatantly disrespectful conduct is easy to recognize but requires someone to step up to call it out as being inappropriate. Students can work with faculty and administration to address those issues. But even if your department doesn't have any dramatically bad behavior going on, you still might not have a welcoming environment for a wide spectrum of people. Implicit bias and microaggressions are harder to recognize but just as damaging to the departmental environment and the community at large. Many people leave physics and astronomy not because of one specific moment but a career of slights and comments. We are all responsible for supporting each other—physics is hard, and we make it through in large part due to the support and guidance of colleagues and friends.

Engaging in serious self-examination is not easy, nor is it very comfortable. Fortunately, every campus has resources available that your chapter can take advantage of. You can work with an office of diversity and inclusion or a women and gender studies program or other support office to learn more. SPS National and your National Council zone councilors are also available to help your local chapter learn to support all of the physics enthusiasts who come through your department. //

LEFT: The UWRF SPS chapter sharing a special meal of Korean food to celebrate the university's ties with South Korea at a regular weekly meeting. Photo courtesy of Earl Blodgett.

To learn more about how the SPS National Council can support your chapter, visit spsnational.org/about/governance/national-council.

Learn about SPS programs and resources at spsnational.org/programs.

Welcoming "Little Sibs" to the Physics Community

by Cait Battle-McDonald and Michaela Guzzetti, SPS Chapter Co-Presidents, and Nalini Easwar, Faculty Liaison, Smith College

Since reviving the Smith College SPS chapter in 2016—a response to the increasing number of physics majors and interest in the subject from new students—members have been dedicated to fostering confidence and creating opportunities for women in the field. One way we've done this successfully is through the Big Sib/Little Sib program, which pairs new students—typically freshmen and sophomores—with junior or senior physics majors.

At Smith, a predominantly women's college, we believe strongly in the importance of representation and building mentoring relationships within the scientific community, especially in physics, where representation of women has stayed at around 20% over the past two decades. Our graduating class averages eight to nine women physics majors every year—at least five times the national average at schools with a comparable number of graduates. We see ourselves in a unique position to make a difference, albeit in small numbers!

Many ideas for accomplishing this were shortlisted at a brainstorming meeting in 2016, and the Big Sib/Little Sib program was one that received enthusiastic support from students. Taking inspiration from a similar program run in Smith's housing communities, Big Sib/Little Sib gives new students an extra resource for questions on classes, research, internships, postgraduation options and opportunities, and more.

The idea came from our first SPS president, Darby Bates, who felt that "establishing a Big Sib program would be a nice way to develop a sense of camaraderie among students of all class years, especially among students [who] don't attend the same courses. I also thought it might help demystify the physics major and minor."

She continues, "The physics Big Sib events were made to provide a fun, relaxed space for students to meet who share a common interest in physics while playing with some of the wonderful physics department toys or watching a physics-related movie. By creating a space where students across class years could bond in a social setting, the program adds a peer-level support system for first-year students who are considering the physics major or minor."

In the 2018–19 academic year, a total of 18 students were involved in the program, nine as big sibs (amounting to half of the upperclassmen physics majors) and nine as little sibs. We recruited big sibs from the list of physics majors and minors in the department and little sibs from intro physics classes. Each recruit filled out a form with both academic and extracurricular interests, and siblings were paired based on their answers. By connecting students who share interests inside and outside of the classroom, we hoped to foster relationships that would go beyond the common connection of physics. Big sibs prepared small gift bags that were given anonymously to their little sibs. A few days later, we held a sibling reveal event at a trivia night sponsored by the Physics Club. As an icebreaker, big and little sibs worked as teams to answer trivia questions.

So far the program has successfully welcomed new members of the community into both the SPS chapter and the physics department. We saw numerous little sibs at events throughout the year, and we plan to continue making the program even stronger, in part by doing more educational outreach events for other groups underrepresented in physics. Increasing inclusion and equity resonates with the mission of the college, and supporting women in science is an important part of that for our chapter. //

LEFT: The 2018–19 big sibs and little sibs at Smith College. Photo courtesy of Nalini Easwar.

ABOVE: SPS member Mackenzie Litz (left) with her "little sib." Photo courtesy of Nalini Easwar.

Jane Jackson BS, MS, and PhD, Physics, Arizona State University

What she does:

Jackson helps high school students become "thinkers," people who can reason based on evidence. Addressing global warming and other 21st-century challenges requires people who can think critically and creatively, see the big picture, and create physical models, according to Jackson. The goal of her work is to prepare students to meet these challenges.

For the last 25 years, Jackson has been codirector of the Modeling Instruction program at Arizona State University(ASU). Modeling instruction is a research-validated teaching method where the classroom becomes a lab and students become scientists. Instead of listening to lectures and working through prescribed experiments or watching a demonstration, students design their own experiments, learn to model physical systems, and confer with one another as scientist peers. "It's hands-on, minds-on, interactive engagement," Jackson says.

Through three-week summer professional development workshops, the ASU program instructs teachers how to create modeling classrooms. More than 1000 Arizona science teachers have been through these workshops, as well as hundreds of teachers from other states and even other countries. As codirector, Jackson oversees the entire program. She hires workshop leaders, recruits participants, supports the leaders and participants, and advocates for teacher professional development funding.

How she got there:

As a teenager, Jackson pondered questions like, What is the essence of reality? What is life? What is the essence of being a human? What is the essence of physical reality? After reading *The Evolution of Physics* by Albert Einstein and Leopold Infeld, she realized that physics might provide some answers to the last question.

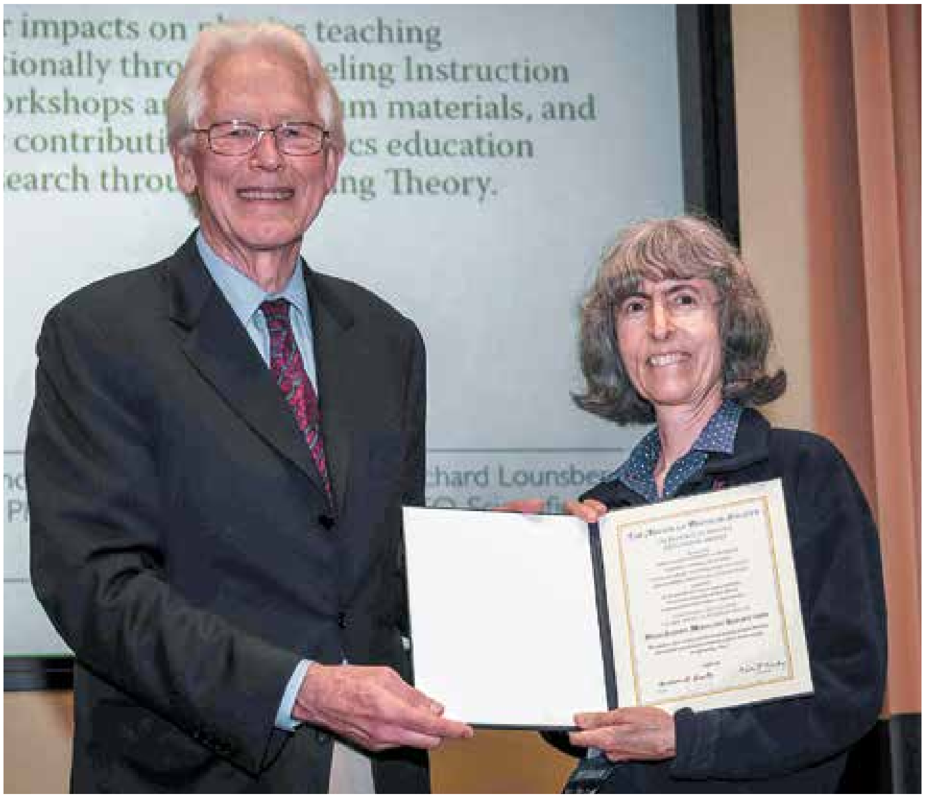
Jackson studied physics at ASU and was active in her local SPS chapter. She recalls her advanced lab class most fondly. "My lab partner and I didn't understand capacitors, so we chose to make one and take measurements on it. Having the freedom to choose a project, in order to understand, made it memorable," she says. She stayed on as a graduate student, working toward a PhD in physics while her husband worked toward a PhD in English.

In 1970, Jackson became the first woman to earn a PhD in physics from ASU. Soon after, she relocated to South Dakota because her husband was offered a job at South Dakota State University. Jackson volunteered in the physics department while their children were young and then taught physics for eight years before returning to Arizona. In Arizona, she taught physics and built an astronomy program at Scottsdale Community College.

"In 1991 I learned about ASU modeling instruction," she says. "I saw that it was [focused on] interactive engagement. It was much better than anything I had been doing. I tried to implement it but failed." She realized that teachers needed to be trained in modeling instruction in order to be successful. A few years later she received a call from David Hestenes, one of her favorite ASU professors. Hestenes had just received a grant for modeling instruction and needed a project director. The rest, as they say, is history. "I don't intend to ever retire because I love working with teachers and I love working in physics," Jackson says.

A message for physics students:

"Persevere," Jackson says. "Physics is at the heart of 21st-century civilization. Physics is key to understanding and addressing the global climate crisis! Keep the love of the physical world paramount; that's why we all chose physics (rather than, say, math or biology). Enhance it with understanding; be a lifelong learner and contributor to a better world." //



LEFT: High School Modeling Instruction was recognized with the 2014 Excellence in Physics Education Award of the American Physical Society (APS). The award was presented to Jane Jackson (right), David Hestenes, and Colleen Megowan by then APS president Malcolm R. Beasley (left) at an APS meeting. Photo courtesy of the American Physical Society.

2019 Individual Award and Scholarship Recipients

The Society of Physics Students congratulates this year's recipients and thanks the generous Sigma Pi Sigma and SPS donors whose support makes these awards possible.

SCHOLARSHIPS

Multiple awards, ranging in value from $2,000 to $5,000, are made each year to individuals showing excellence in academics, SPS participation, and additional criteria. Learn more and see photos and bios of the recipients at spsnational.org/awards/ scholarships.

SPS Outstanding Leadership Scholarship
Evan Ulrich, *Juniata College*

SPS Leadership Scholarships
Jacob Adamczyk, *Cleveland State University*
Swapnil Bhatta, *University of Southern Mississippi*
Kevin Fernando, *University of Central Florida*
Lucas Hanson, *Rutgers University*
Nolan King, *University of Texas at Dallas*
Matthew Macasadia, *Texas Lutheran University*
Connor Pecar, *Duquesne University*
Roy Salinas, *Abilene Christian University*
Samantha Tietjen, *Cleveland State University*

SPS Future Teacher Scholarship
Katie Syer, *Augustana College*

Peggy Dixon Two-Year Scholarship
Vincent Thompson, *Indiana University of Pennsylvania*

Herbert Levy Memorial Scholarship
Roel Olvera, *Texas Lutheran University*

AWIS Kirsten R. Lorentzen Award
Alexandra Detweiler, *Illinois Institute of Technology*

Aysen Tunca Memorial Scholarship
Ruth Willet, *Kettering University*

Science Systems and Applications, Inc. (SSAI) Academic Scholarship
Kristiana Smith, *Rhodes College*

Science Systems and Applications, Inc. (SSAI) Underrepresented Student Scholarship
Martha Jesuit, *Coe College*

SPS AWARD FOR OUTSTANDING UNDERGRADUATE RESEARCH

Awards are made to individuals for outstanding research conducted as an undergraduate. Winners are awarded $1,800 to present their research at an AIP Member Society meeting and receive $500 for themselves and $500 for their SPS chapter. The runner-up receives $400 to present their research at an AIP Member Society meeting. Learn more at spsnational.org/awards/outstanding-undergraduate-research.

Winners
Martha Jesuit, *Coe College*
Terance Schuh, *The College of New Jersey*

Runner-Up
Nolan King, *University of Texas at Dallas*

2019 SPS SUMMER INTERNS

The SPS summer internship program offers 10-week positions for undergraduate physics students in science research, education, and policy with organizations in the greater Washington, DC, area. Students are placed in organizations that use the interns' energy and viewpoints to engage with the community and promote the advancement of physics and astronomy.

Megan Anderson
William Jewell College, *Society of Rheology History Intern*

Isabel Bishop
Coe College, *APS Public Engagement Intern*

Jacqueline Blaum
Iowa State University, *APS Career Programs Intern*

Nour Ibrahim
Embry-Riddle Aeronautical University – Arizona, *SPS Science Outreach Catalyst Kit Intern*

Giavanna Jadick
Duke University, *AIP Mather Public Policy Intern – US House Committee on Science, Space, and Technology*

Jeremiah O'Mahony
Sarah Lawrence College, *Physics Today Science Writing Intern*

Anna Perry
Gettysburg College, *AIP History of Diversity in the Physical Sciences Intern*

Andrew Phipps
Brigham Young University – Idaho, *APS Education & Diversity Intern*

Sariah Mevs Phipps
Brigham Young University – Idaho, *OSA Professional Development & Outreach Programs Intern*

Nolan Roth
High Point University, *NASA Research Intern: Space Exploration*

Catherine Ryan
The Pennsylvania State University, *AIP Niels Bohr Library & Archives / Education & Diversity Intern*

Amber Sammons
Illinois State University, *AAPT Teacher Professional Development Programs Intern*

Terance Schuh
The College of New Jersey, *NASA Research Intern: Cosmic Microwave Background*

Samantha Staskiewicz
The College of New Jersey *AIP Science Policy News Intern*

Nicholas Stubblefield
Boston College, *AIP Mather Public Policy Intern – NIST*

Joseph Tibbs
University of Northern Iowa, *NIST Research Intern*

Building a High-Powered Rocketry Program

by Shannon Clardy, Professor of Physics,
Henderson State University

After deciding to add an engineering major to our physics department, we knew we needed collaborative projects that would utilize the skill sets of both majors to help us get our research off the ground (pun intended). In search of something exciting, unique, and encompassing both engineering and physics, we landed on high-powered rocketry.

If you like model rockets, you will love high-powered rocketry. It is literally a blast! To get started, a colleague and I became members of the National Association of Rocketry (NAR). Along with Tripoli Rocketry Association, the NAR upholds standards and best practices to ensure safety in sport-rocketry. Both are nonprofit scientific organizations dedicated to space-modeling. After becoming members, we started Reddie Rockets, NAR section no. 777—the first rocketry section in Arkansas. The NAR makes the process easy and provides a significant insurance benefit for approved launch sites.

Rocket motors aren't classified by the altitude obtained in flight but rather by the impulse and total thrust provided to the rocket. Typically, A–D motors are available at the hobby store, but high-power certification is required to fly rockets with motors I–O, which have over 160 Newton-seconds (N s) of impulse. This means that if it fires for 1.5 seconds, it applies 160/1.5 = 106.6 Newtons of force each second it is firing. There are federal regulations controlling how these motors are stored, shipped, purchased, and used—you must be a member of either NAR or Tripoli to even purchase them, and you need an FAA waiver for launch airspace.

There are three levels of certification in high-powered rocketry.

Level-1 certification involves building, flying, and recovering a rocket with an H- or I-level motor. An I motor has up to 640 N s of impulse; for comparison, a C motor has 10 N s. The rocket cannot sustain significant damage and must be able to fly again. In order to verify a launch for certification, two NAR members with that level of certification or higher must be present.

To earn their level-1 certifications, our students build the Loc Precision Hi-Tech H45 rocket, a less-expensive, sturdy rocket. The rocket comes in a kit, but we make a few modifications, such as adding an Aero Pack motor retainer to hold the motor in the rocket and threading the recovery harness through the motor mounts. The recovery harness keeps the body and the nose cone of the rocket tied together when the parachute pops out. When the parachute is blown out of the rocket, it causes a significant deceleration in the rate of falling, and if the recovery harness isn't attached well, the rocket may come down in separate pieces. Students fly this rocket on H125–H152 motors and generally achieve an altitude of around 3,500 feet.

Level-2 rocketry certification is similar to level-1 certification but involves higher impulse motors (J and K motors, up to 2,560 N s of impulse) and a written exam covering safety and regulations. Level-3 motors include L–O motors, which can have up to 40,960 N s of impulse. For certification at this level, the flyer must incorporate redundant electronic parachute deployment systems rather than using a delay grain and a charge. Significant documentation is required for this level of certification, and we are currently working toward our qualification by flying rockets with electronic parachute deployment.

One of the benefits of developing a high-powered rocketry program is the wealth of possible research topics. Our students have studied mechanisms for using altimeters to deploy parachutes, developed tracking devices, designed camera and electronics mounting systems, considered the effects of weight and balance on rocket trajectory, simulated thrust and impulse in programs like RockSim and OpenRocket, and analyzed forces on different shapes of airfoils. In addition, the program stimulates fellowship, fun, and outreach. Students have the opportunity to participate in national rocketry competitions, and we work with community groups of various sizes for workshops, public model-rocket launches, and camps. Rocketry is captivating for all ages, as it will propel us into the future of space exploration. //

TOP: Alex Riddell, Rick McDaniel, Shannon Clardy, Calvin Clardy (in front), Brian Terry, Jessy Green, Matthew Taber, and Todd Baum show off their rockets before launch. Photo courtesy of Shannon Clardy.

ABOVE: Cooper Wade, Becca Voss, and Josh Jasper build Loc Precision H45 rockets for their level-1 certification. Photo courtesy of Shannon Clardy.

To learn more, check out the NAR at nar.org and the Tripoli Rocketry Association at tripoli.org.

Pedal Power Puzzlers

by Katherine Zaunbrecher, SPS National Council Member-at-Large, and
Brad R. Conrad, Director of SPS & ΣΠΣ

"Life is like riding a **bicycle**. To keep your balance, you must keep moving." — Albert Einstein

Bicycles have been around for 200 years and, in that short time, have completely changed the way we think about travel and how humans interact with machines.[1] We can learn a lot about physics by thinking about bikes and cycling-powered human locomotion. Bicycles are also an amazing source of Fermi problems—sweeping questions that can be answered with a little physics, a little critical thinking, and some back-of-the-envelope estimates. For more on Fermi problems, check out the Winter 2017 puzzler.[2]

To get warmed up, let's work a problem together. Note that our estimate demonstrates possible paths to the solution—not the only paths. One of the great things about physics is that it often allows us to reach a solution via several different paths.

WHAT IS THE AVERAGE OUTPUT POWER OF A PERSON RIDING A BICYCLE?

The simplest path to power is to estimate the force needed to maintain a constant speed. First, let's estimate the speed of a person riding a bike. Google Maps assumes an average speed of about 10 mph when giving the time estimate for how long it takes to get to a destination when using a bike.[3] It turns out that this is totally reasonable, as it's faster than walking, which is a few miles per hour, and slower than a car, which is about 60 mph. This also leads to a fun game—by how much can you beat the Google estimated arrival time?

Now, let's relate this sustained velocity to power. From our first-year physics course, we remember that the power output P of a person on a bike is directly proportional to the force applied F, the bike velocity v, and the distance x over which the force is applied. These are quantities that we can estimate:

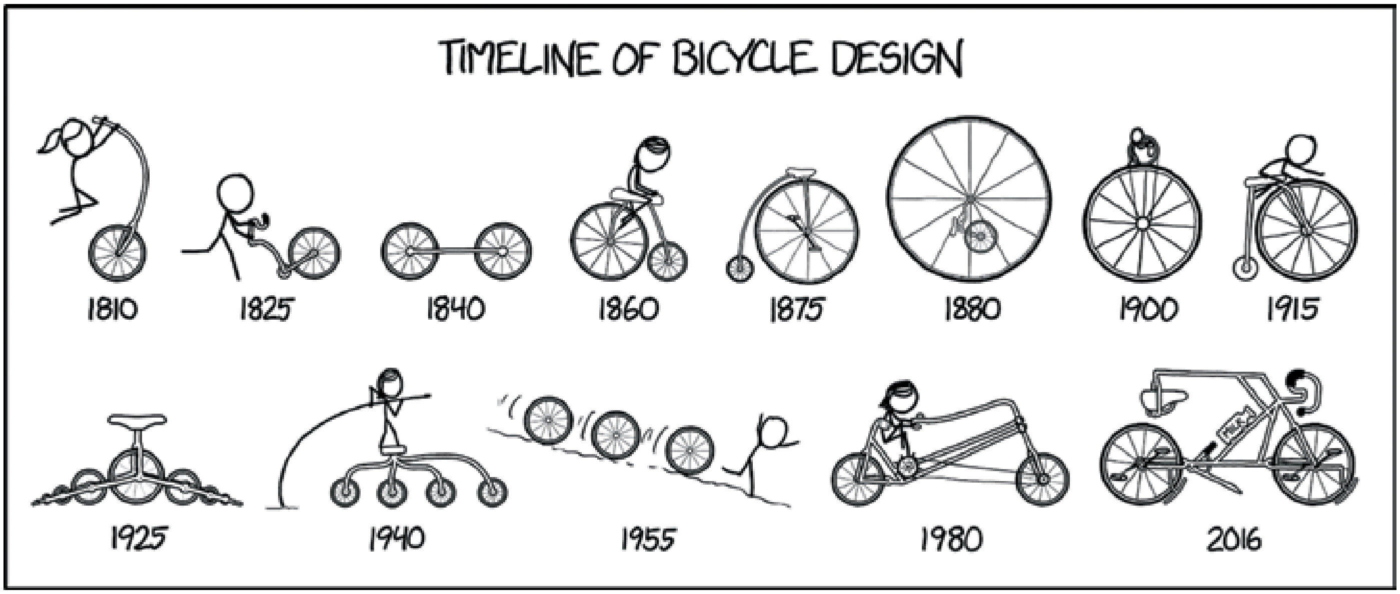
$$P = F \cdot v$$

For completeness, let's take a look at the units of this relationship.

$$[Watts] = \frac{[work]}{[time]} = \frac{[force] \cdot [distance]}{[time]} = \frac{[N] \cdot [m]}{[s]}$$

We can also think about this problem in terms of angular measurements, using the applied torque τ and angular velocity ω (since we're talking about bicycles with circular wheels, for Newton's sake!) to calculate power:

$$P = \tau \cdot \omega$$



ABOVE: Image courtesy of Randall Munroe, xkcd.com/1673/.

Again, let's check the units for completeness and to ensure we're going down the right path:

$$[Watts] = [Torque] \cdot [Angular\ Velocity] = [N \cdot m] \cdot [radians/s] = \frac{[N] \cdot [m]}{[s]}$$

Note that radians is a dimensionless quantity, so it disappears in the line above. We can assume that an *average* comfortable strolling speed on two wheels is on the order of 1.5 rotations per second, which comes out to 3π radians per second. Remember, we just need reasonable estimates for these quantities. If we are off a little here and there, we'll still be on the right track.

For the quantity radius r, we consider the length of the crank arm (the part attached to your pedal that transfers the motion to the chain), which is about 175 mm (7 inches).

Now we dive into the hard part of this approach: How do we estimate the torque? Or the force F applied to the crank arm?

We can assume that the laziest person in the world gets most of their help from gravity. When they place their legs on both of the pedals, the force exerted is their mass times the gravitational constant. Let us assume a mass of 15 kg per leg and 10 m/s^2 for the acceleration due to gravity. We also know that the applied force will be sinusoidal since the torque applied is a cross product with a magnitude that depends on the angle θ between the crank arm and the force applied by the leg:

$$\tau = r \times F = rF_{max} \sin\theta$$

Thus, when one of the pedals is at the top of its motion, the force and momentum of the crank arm are parallel and there is no torque. We'll call this angle zero. But as the crank arm continues to move around, the angle increases and the torque increases. When the crank arm and leg are π/2 radians apart, the instantaneous force is at its maximum. The torque then decreases until the pedal reaches the very bottom of the rotational path (at π radians). If you assume a sinusoidal model for force, you can estimate the average force F_{ave} as the integral of the sine wave from zero to pi:

$$F_{ave} = \frac{1}{\pi}\int_0^{\pi} F_{max} \sin\theta \, d\theta = \frac{2}{\pi} F_{max}$$

Thus the average force F_{ave} from one leg of a person is

$$F_{ave} = \frac{2}{\pi} 15\ kg \cdot 10 \frac{m}{s^2}$$

which is about 100 N. Therefore we can put it all together and write out the average power as

$$P_{ave} = r \cdot F_{ave} \cdot \omega = 0.175\ m \cdot 100\ N \cdot (3\pi) = 160\ W$$

NOW THAT YOU'RE WARMED UP, IT'S TIME FOR THE PHYSICS PUZZLER:

A person wants to ramp over the Mississippi River on a bike. How fast would an adult human have to go on a bicycle and at what ramp launch angle to make it across the Mississippi River and land in New Orleans?

Hint: From New Orleans you can see people on the opposite riverbank, but they look small. Try to answer this ***without*** *looking up anything on the web.*

EXTRA PUZZLER CHALLENGE:

Bikes are more stable when moving forward without a human on them. Why?

Hint: Seriously, they are.

After you write down your logic, check out the minute-physics video "How Do Bikes Stay Up?"[4] There are studies that explain that the popular gyroscopic answer is mostly a myth.[5]

OTHER PUZZLES YOU CAN TRY:

- Which brake provides better (higher) braking power, front or back?
- Rotational motion requires friction, so what is the maximum acceleration of someone on a bike without flipping?
- How many street tacos would you need to eat in order to power a ride from NYC to LA? //

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LEFT: Mississippi River. NASA Earth Observatory image created by Jesse Allen and Robert Simmon using Landsat data provided by the United States Geological Survey.

FEATURE

Physics — A Space for You

by Kayla Stephens, SPS Programs Manager

> **"Once I got into space, I was feeling very comfortable in the universe. I felt like I had a right to be anywhere in this universe, that I belonged here as much as any speck of stardust, any comet, any planet."**
> **– Mae Jemison**

As the first African American woman astronaut, Dr. Mae Jemison is no stranger to the disparities present within the physical science community. Attending Stanford University in the early 1970s at the age of 16, Jemison persevered using her youthful optimism to succeed in a world of discrimination and where the odds were not in her favor.[1,2] Although Jemison is viewed as a role model, specifically for young women of color, she suggests that it takes people from all ethnicities and backgrounds to recognize that any child can excel in any field given the opportunity.[3]

The Society of Physics Students continuously strives to create a community where everyone, regardless of cultural background, gender identity, or sexual orientation, feels as comfortable as Jemison did as she orbited in space. SPS recognizes that although there have been great improvements over the past years within physics and astronomy, the work is far from over. The advancement of equity, diversity, and inclusion is not just simply opening doors but focusing on creating environments that are proportionately representative of all student demographics and support practices that meet the needs of diverse learners.[4] Ultimately, it's important that we work to make sure that anyone can see themselves as a scientist and provide tools allowing students to reach their full potential.

The feature stories in this issue highlight contributions and initiatives of SPS members that exemplify the goal of providing adequate opportunities to anyone that is interested in physics. You will read about how the SPS chapter from Missouri Southern State University is impacting their local community by stimulating passion for physics in pre-K to adult learners, look at efforts to make astronomy inclusive and accessible to the blind and visually impaired, and explore various perspectives on how to foster inclusive physics spaces. You'll also read about how research is informing best practices for teaching physics and about how the SPS National Council has recently adopted two new inclusivity statements: *Diversity, Inclusion and Ethics* and *Common Rooms, Department Health, and Identity*. We hope these stories inspire you to consider what you can do to create a more inclusive physics community. //

ABOVE: The first African American woman in space, Dr. Mae C. Jemison. Photo courtesy of The Museum of Fine Arts, Houston.

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FEATURE

Active Learning Isn't Enough:

Cultivating Inclusive Learning Environments

by Dimitri R. Dounas-Frazer, Assistant Professor of Physics and Astronomy, Western Washington University and Jacquelyn J. Chini, Assistant Professor of Physics, University of Central Florida

We are physics instructors and education researchers who combine active learning and lecturing strategies in our courses. Active learning is the focus of many efforts to improve postsecondary instruction in physics and other STEM fields. The term refers to a wide range of teaching strategies[1] such as Peer Instruction[2] and SCALE-UP,[3] but essentially, active learning strategies create more frequent and varied opportunities for students to interact with each other and with their instructors.

Overall, a preponderance of evidence demonstrates that active learning leads to certain improved student outcomes.[4] However, when studying the impacts of active learning, researchers often focus on the aggregate performance of all students in a given course. This approach overlooks students' individual experiences and obscures barriers to inclusivity that are unique to, or exacerbated by, active learning strategies.

Current STEM education research and our own experiences reveal that active learning strategies create new challenges for inclusion in the classroom. Increased in-class interactions provide increased opportunities for students to experience harm, especially those students who are targeted by racism, ableism, sexism, cissexism, or heterosexism. In this article, we describe some of the challenges that come along with active learning and suggest actions that students and faculty members can take to cultivate inclusive active learning environments.

Some researchers have demonstrated benefits to marginalized groups (e.g., students of color and white women) from specific active learning strategies (e.g., SCALE-UP[5] and modeling instruction[6]). Based on these findings, instructors may decide to implement active learning as a step toward improving inclusion in their classrooms or departments. Such a goal is consistent with the American Association of Physics Teachers (AAPT) statement, Fostering Safe and Inclusive Learning Environments: "AAPT envisions schools and classrooms where students of all races, ethnicities, genders, religions and identities can realize their fullest potential in physics, free from bullying, harassment or hostilities."[7]

However, few (if any) active learning strategies were developed specifically to reduce or eliminate bullying, harassment, or hostilities in the classroom. Moreover, the physics education research community has historically focused on students who "are better prepared mathematically and are less diverse than the overall physics student population."[8] Most previous studies treat gender as binary, a practice that erases nonbinary students, misgenders them, and misconstrues findings about the impacts of research-based curricula.[9] In summer 2019, a group of physics education researchers of color wrote a reflection on their experiences in the physics education research community. One theme they shared was, "It is very hurtful to hear students being referred to using disparaging terms. Most notably, students have been labeled or categorized as 'weaker,' 'lowest,' 'low-level,' 'low-income,' 'not as good,' and other such terms that we have heard in presentations and seen printed in publications. The use of terms like these demonstrates a lack of understanding of the inequalities in our society and more egregiously, it attributes a student's circumstances and performance, which is based on a variety of factors, to their identity."[10] In addition to these general trends, recent research challenges the idea that any active learning strategy is better than traditional lecture-based instruction for all students:

- Black women have been excluded from physics study groups by other students, leading to feelings of isolation and creating a barrier to learning physics and succeeding on exams.[1]
- Introductory physics students who identify with attention-deficit/hyperactivity disorder (ADHD) reported that active learning strategies could increase barriers to their learning, as they have to develop new learning strategies to prepare for a class like SCALE-UP.[12]
- For mixed-gender student groups working interactively on a mathematics task, social cohesion (i.e., the extent to which group members enjoy each other's presence and feel like they belong) decreased in groups with more men.[13]
- In introductory biology courses for majors, Asian American and international students were more likely than white American students to prefer the role of listener during group work and to report that someone else from their group dominated discussions.[14]
- For lesbian, gay, bisexual, transgender, queer, and asexual (LGBTQA) students in an active learning biology course, increased interactions with peers created increased opportunities to come out and connect with others similar to them but also increased chances of being outed or misgendered.[15]
- Certain active learning strategies, such as cold calling (e.g., calling on nonvolunteering students), increased student anxiety in a large-enrollment biology course.[16]

It is also important to listen to student's self-authored voices. For example, Anna Perry, a student at Gettysburg College, describes how problematic peer-to-peer dynamics in a flipped physics classroom contributed to her decision to change her major from physics to Africana studies.[17]

For these reasons, we caution against framing active learning strategies as inclusive on their own.

Working toward inclusion of all participants requires action from both physics instructors and students. Below we outline several steps that they can take to enhance the inclusivity of any learning environment in which learners regularly interact with one another. We emphasize that these recommendations should be viewed as one part of a comprehensive departmental strategy.

Prioritize ongoing self-education about bias. The ability to notice and address problematic behavior is a skill that must be continually practiced and relearned. To develop this skill, instructors and students should invest in ongoing self-education. This could include participating in training sessions at universities, in local communities, or during professional conferences. In addition to reaching out to the few physicists with the relevant expertise to provide this training, we must also turn to nonphysicist experts in race, disability, gender, and sexuality. For example, at recent AAPT conferences, Sherry Marts,[18] Joseph Williams,[19] and Simone Kolysh[20] have each run multiple workshops on sexual harassment, racial microaggressions, and oppression, respectively.

Establish classroom norms in the first week of class. Explicit norms for behavior in and out of the classroom can reduce the likelihood of violating unarticulated expectations. There are multiple approaches to setting class norms. Instructors could incorporate pre-established norms, like those developed by STEP UP, a national organization focused on engaging young women in physics.[21] Alternatively, instructors and students could cogenerate conditions for success using the appreciative interview technique.[22,23] Once norms have been set, it is everyone's responsibility to honor them. The process of creating, communicating, and upholding norms should be equitable and flexible; some norms might not make sense for some students.

Monitor, recognize, and address inappropriate behavior during class. Racist, ableist, sexist, cissexist, and heterosexist behaviors have no place in any physics learning environment. Such behaviors include microaggressions, harassment, slurs, misgendering, and other forms of marginalization. Identifying and disrupting these behaviors is the professional responsibility of all physics students, instructors, and researchers. For example, AAPT[7] and the American Physical Society (APS)[24] have called on physicists to address and overcome our own biases.

Foster inclusive learning environments outside of the classroom. Out-of-class interactions are just as important as those occurring in class. Research by Katemari Rosa and Felicia Moore Mensah demonstrates that exclusion from study groups is one factor contributing to the isolation of black women physics students.[11] If a physics department maintains a student study space, the department should establish and uphold norms for this space. To monitor overall culture and climate of the department, department chairs can administer anonymous surveys or enlist external organizations for support, such as a site visit by the APS Committee on the Status of Women.[25] To foster an inclusive environment beyond the classroom and throughout the department, students, faculty, and staff should consider working together; indeed, such partnerships are one of the principles for departmental change described by physics education researchers Gina Quan, Joel Corbo, and their colleagues in the Departmental Action Team project.[26]

Ensure that examples, stories, and jokes are appropriate. When providing real-life examples or telling stories, we often assume a certain level of cultural familiarity among listeners. Discussions about ethics carry a unique opportunity for centering examples that may threaten inclusion.[27] Jokes further function to position certain behaviors as typical or absurd,[28] and they may have an unintended impact on some listeners.[29] Erroneous assumptions about which experiences are common knowledge or which behaviors are absurd alienate some physics learners, likely those from minoritized groups.

ABOVE: Jackie Chini (second from left) and Learning Assistants at the University of Central Florida explore a favorite active learning demonstration on a spinning stool. Photo by Courtney Shapiro, courtesy of the APS PhysTEC program at UCF.

To avoid this kind of alienation, it is important for everyone to think carefully about the assumptions and punchlines of their examples, stories, and jokes. Examples, stories, and jokes of a sexual nature (whether explicit or implicit) are never appropriate.

Acknowledge that bias informs students' evaluation of instruction. Student evaluations have low correlation with student learning.[30,31] Some instructors receive worse ratings when they augment lecturing with active learning strategies,[32] and sexist biases in student evaluations are well documented.[31,33,34] Both authors have received evaluations that focus on appearance rather than teaching practices. Nevertheless, at most institutions, student evaluations remain a factor in decisions about contract renewal, promotion, or tenure for adjunct faculty, long-term lecturers, and tenure-track faculty. Students therefore have a responsibility to consider their own biases when filling out evaluations and to provide thoughtful feedback about teaching practices. Comments about instructors' perceived intelligence or attractiveness are never appropriate.

Be flexible. No active learning strategy works well for all students in all contexts at all times, and some strategies are counterproductive for some students. Moreover, what works for one student in the first few weeks of class might not work in the last few weeks; health issues, job requirements, and dependent care responsibilities fluctuate over time and can be unpredictable. When the format of the class doesn't work for a student, the student and instructor should be open to discussing options that could help the student meet the learning objectives of the course within existing constraints. Because there are many barriers to receiving university-sanctioned accommodations,[35] the absence of such accommodations should not prevent instructors from working with students to address individualized needs.

Getting started can feel overwhelming, but there are a variety of resources that you can (and should) build from. For instance, consider the following resources for supporting students of color: *The Physics Teacher* recently published a set of articles on race and physics teaching, edited by Geraldine Cochran and Gary White;[36] Chanda Prescod-Weinstein has written a sequence of essays titled Surviving and Thriving as an Underrepresented Minority Astro/Physics Student;[37] and the American Institute of Physics (AIP) TEAM-UP Task Force is working toward a report on strategies for recruiting and retaining black physics students.[38] Further, to provide a truly equitable and inclusive learning environment for physics students, departments must also consider inclusive hiring and admissions practices, possibly including affirmative action practices.[39–41]

Active learning strategies do not necessarily imply equitable or inclusive learning environments on their own. Instructors and students must work together to ensure that interactions in and beyond the classroom are inclusive. These recommendations are meant to be a starting point for reflection and action, not an exhaustive list. We hope that the ideas presented here will inspire readers to continually and thoughtfully improve the learning environment in their own classrooms. //

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FEATURE

Fostering

Inclusive Physics Spaces

by Jeremiah O'Mahony, 2019 SPS Summer Intern and SPS Member, Sarah Lawrence College

Physics has a long way to go toward equality. Despite being, arguably, the most universal science, it's one of the most exclusive. According to data published by the American Institute of Physics, only a fifth of physics PhDs went to women in 2017—and the numbers for physicists of color are lower.[1] The percentage of physics degrees at all levels earned by women, African Americans, Hispanic Americans, American Indian/Alaska Natives, and Native Hawaiians are far less than what you would expect based on the US population distribution.[2]

Changing the national landscape sounds daunting, but think about it this way. Creating a more inclusive local physics community can start with you. If you and your chapter want to take steps toward including everyone, start by listening to everyone. "Empathy is about opening ourselves up to each other's stories," said Nicole Cabrera Salazar, a PhD astrophysicist who has launched several initiatives aimed at bringing more young people with minority identities into physics.

To actually hear other stories, though, people have to trust you enough to share themselves. "For someone to be vulnerable with me, I have to be vulnerable first," Cabrera Salazar said. She recommends "leading with vulnerability": be the first to open up and share your story.

Cabrera Salazar admits that learning how to be vulnerable and empathetic is hard. It's scary to trust someone that you know only through physics. Plus, hearing and accepting someone else's story grates against one of physicists' most sacred commandments: No anecdotes. "As physicists, we have the thought process of, Where's the data?" said Jessica Esquivel, a lesbian, black, and Latina postdoc at Fermilab. "I get that. And there is data. Still, we should give the experiences of those marginalized people a greater weight."

"There is an expectation that human beings can't be human while they are doing their science," said Tanmoy Laskar, a queer postdoc in astrophysics at the University of Bath. "Spaces can be made more inclusive by adding pride flags, but [real change happens] by talking about challenges faced by people with other stories."

"Of course," he clarified, "that's not to knock the power of pride flags." He has a few prominently displayed in his office and recommends that classrooms and lounges should have signs designating them as safe spaces. But before you deck out your classroom or lounge with signs, have conversations with people in the space to make sure that you're all on the same page about the importance of inclusivity and what that means. "The critical first step is a cultural transformation [aimed] at ensuring all participants behave in an inclusive manner to each other," Laskar warned. "Without such a transformation, all outward or manifest signs of inclusivity in the space are ineffective and may even be harmful."

When you're outfitting your space, make sure you get everyone's opinion for what goes on the walls and what images are used as screensavers and monitor backgrounds. When new students arrive, make sure they have equal input in redecorating the space. It makes a difference to a new LGBT+ student if he sees a queer scientist smiling down from a poster that he suggested. "The availability of surfaces for affixing decorating allows people to amend the space to express identity," Laskar said.

> If a marginalized student sees pride flags when she comes to work but still experiences prejudice from her colleagues, those flags are just pieces of fabric.

On the flip side of that, do your research when you consider posters of famous scientists. While science history is studded with great discoveries, the people who made those discoveries often held opinions that don't reflect inclusivity—ranging from the slightly problematic to the virulently racist. Be open to taking down certain posters if someone in your space expresses their

BOTTOM LEFT: Jessica Esquivel, postdoctoral research associate at Fermilab, at WakandaCon in Chicago. Photo courtesy of Fermilab, Bailey Bradford.

LEFT: Nicole Cabrera Salazar founded Astronomy Peer Advising Leaders programs, or AstroPAL, for young astronomers to meet and talk about issues in their careers with older peers. Photo courtesy of Cabrera Salazar.

discomfort. Similarly, be mindful of the range of diversity portrayed on your walls. Physics Nobel laureates are worth celebrating, but a gallery of their faces probably won't help you create a welcoming atmosphere.

"No discussion of inclusivity is complete without a mention of accessibility," said Laskar. Along with adding wheelchair ramps, door signs for the visually impaired, and gender-neutral restrooms, he recommends making your space as easy to reconfigure as you can. Making sure that desks and chairs can be moved so the student in a wheelchair doesn't have to sit in an aisle goes a long way to making them feel included, as does having an option to change lighting for people negatively affected by bright lights or fluorescents. "Reconfigurable spaces are versatile and allow groups of different sizes and intent to set up the space in a fashion most accessible to their members," Laskar said.

The way we treat each other and carry forward the promises of signs, flags, and reconfigurable spaces is equally important. Even in a classroom with all those things, a stray ignorant slur used in a joke can bring it all crashing down. Don't use words that have historically been used to bring down marginalized groups—whether or not a marginalized person is in earshot. Listen to marginalized people and take their word for it when they say that a word is offensive. For instance, some people in the LGBT+ community are comfortable with the term "queer" and some are not. Both positions are valid. Either way, trust the people in your community when it comes to that terminology. They are the authorities on their own identities.

Even beyond discussions of identities, listen to each other. Megan Anderson, former SPS National Councilperson and member of the Executive Committee (not to mention my fellow SPS intern this summer), has noticed that people who are young, quiet, or new to physics are often ignored in group discussions. She urges SPS members to open up the cliques that may form within physics departments. "Our social positions impact the way we think and communicate," said Anderson, "and we must respect different manifestations of this as intellectually valid and valuable."

You don't have to be satisfied with changing your immediate space, though. As young and upcoming members of your institution's physics department, your voices matter. You and your community can organize and petition your department for the changes you've been looking for in your chapter or classroom.

For nonmarginalized students, Cabrera Salazar said, use your voice. The unfortunate truth is that if your marginalized colleagues bring up issues important to them to people in power, they will have less chance of being heard than you do. "[You] have the power to speak on things that [your] minority colleagues may not be able to," Cabrera Salazar said. "Know your power."

Marginalized students have power too. You may get a lot of attention by just being a member of your identity group. "Being part of these marginalized groups, people are going to look at you as the model minority," said Esquivel, "because you're probably the only black person they know." That attention will bring you lots of opportunities to shine and a lot of offers to be part of projects. Accept those offers strategically, Esquivel says, and use your successes to prove that you're someone to be listened to.

Even though being vocal can potentially be rewarding, it's often draining for people of marginalized communities. That's why Cabrera Salazar tells her marginalized students: Understand your limits. Don't engage in activism that completely exhausts you. For questions that are too draining, "Just don't be available to answer those," said Cabrera Salazar. "Have intentional boundaries."

Above everything else, Esquivel focuses on intersectionality in her activism. "Change for the most marginalized people in a group helps everyone [in the group]," she said. So whether you're trying to affect change in your department, your chapter, or even your lab, remember to include everyone in the universal science. //

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FEATURE

Physics Across the Ages:

Engaging the Community from Pre-K to Adults

by Dr. Jency Sundararajan, Associate Professor of Physics, SPS Chapter Advisor, and Dr. Shayna Burchett, Assistant Professor of Chemistry, SPS Member, Missouri Southern State University

Physics is for *everyone*. It's in everything we do, everything that surrounds us. That is why it's important to encourage enthusiasm for physics. Enthusiasm and excitement provoke curiosity, which makes learning fun and enjoyable.

Missouri Southern State University's SPS chapter constantly strives to increase excitement about physics and help everyone in the community feel welcomed. Our chapter participates in several outreach events throughout the year, facilitating active interactions with the audience while also promoting personal connections, leadership experience, and communication skills. We aim to make physics entertaining for all ages via hands-on activities, fun demonstrations, dynamic interactions, and thought-provoking discussions.

In an event for some of the youngest in our community, we joined hands with the Chemistry Club and Women in Science on campus to entertain pre-kindergarten children—the curious and enthusiastic little scientists at

ABOVE: Children at NICU Freeman watch the alignment of magnetic field lines as they move the magnets.

LEFT: One of the students from Lion Cub Academy shows off a cool new hairdo.

Photos courtesy of Dr. Jency Sundararajan.

MSSU's Lion Cub Academy—with some super cool experiments. The children eagerly made slime and yummy liquid nitrogen ice cream and participated in a friendly competition to crown "Mr. Hulk" as the one who could pop a balloon on a bed of nails the fastest. Two groups competed to demolish a paper cup castle with a mini-launcher. All had fun watching their friends try out new hairdos with a Van de Graaff generator, and some performed color-changing chemistry experiments.

At Spring Grove Primary Center in Galena, Kansas, first graders enthusiastically participated in physics activity booths and were excited to watch science in action. Meanwhile, first graders from Columbia Elementary toured the MSSU campus, as they do annually, learning about science through some fun demos along the way.

MSSU Women in Science (WIS), which launched in Spring 2019, collaborated with SPS to perform physics demos for fourth and fifth graders at Thomas Jefferson Independent Day School and inspire young children, especially girls, to pursue degrees in science. We also held a reading event that focused on the contributions of women scientists to various fields. The students were actively involved in the joint event, asking and answering questions, volunteering for demos, and learning about women scientists.

At the middle school level, our chapter actively engages local students participating in the Missouri Southern Regional Science Fair. The students, who are burning with curiosity and excitement about physics, present scientific research findings and participate in hands-on SPS-led activities.

Sophomore Day is an annual on-campus event in which area high school sophomores tour the campus to learn about the wide variety of degree programs and opportunities at the university. In order to engage the students with conceptual assumptions, analysis, and simulations, our SPS chapter collaborated with the Math Club to set up multiple mini-launch stations with variable parameters. We challenged the sophomores to hit the target in a minimum number of trials. We also performed discussion-based demos on inertia, angular momentum, low-friction tracks, wave motion, the electromagnetic spectrum, and static electricity.

At the invitation of high school physics teachers at Thomas Jefferson Independent Day School, our SPS chapter gave a talk highlighting the importance of pursuing science degrees and women in STEM for ninth graders. We also performed demonstrations on waves, rotational motion, circuits, electricity, and magnetism. The students particularly enjoyed building circuits in groups, measuring current and voltage.

Children's Miracle Network Hospitals at Freeman Health System invited our chapter to provide an activity booth at the fifth annual Neonatal Intensive Care Unit (NICU) reunion for Freeman NICU graduates and their families. In response, SPS students hosted an interactive booth featuring angular momentum demonstrations, boom whackers, magnetic slime, bubbles, a bed of nails, and other activities.

Every September, Missouri Southern sponsors the Third Thursday event, which spotlights local art, music, entertainment, and food on downtown Joplin's Main Street. This is a great opportunity to communicate science to a diverse cross section of the local community. SPS members are actively involved in this event, presenting physics demos and conveying the field's complex concepts in simple, efficient, and powerful ways.

Whether working with preschool students or adults, our goal is to create a motivating environment that stimulates an interest and passion for physics. "The introduction of science at an early age enhances a child's cognitive development through curiosity and wonder," says Nikki Tappana, director of the Lion Cub Academy. "The [SPS] members cultivated a sense of science wonder for the children and encouraged them to seek out more scientific information on topics relevant to their everyday lives." We hope this holds true for every person that attends one of our outreach events. //



ABOVE LEFT: Middle schoolers try out a rotating platform demonstrating the conservation of angular momentum.

ABOVE MIDDLE: Cade Hensley, MSSU SPS secretary, explains the concept of pressure to the first graders and performs the balloon-on-the-bed-of-nails demo.

ABOVE RIGHT: Dr. Rabindra Bajracharya challenges high school students to pull out the dollar bill without disturbing the bottles, thereby demonstrating inertia.

RIGHT: Lion Cub Academy kids loved watching how to make liquid nitrogen ice cream.

Photos courtesy of Dr. Jency Sundararajan.

FEATURE

The Society of Physics Students:

A Commitment to Diversity & Inclusion

by Chloe Ong, Adelphi University, and Megan Anderson, William Jewell College, 2018–19 Associate Zone Councilors, SPS Governance Committee Members

SPS isn't a static organization; your elected leadership—the SPS National Council—is constantly revisiting our mission, policies, and values. Have you ever noticed the "Governance" tab under the "About" section of the SPS website? (Go ahead, click on it - we'll happily wait.) This page may not look terribly exciting, but it describes the structure and values that give SPS life. As members of your 2018–19 National Council Governance Committee, we are thrilled to introduce two new official SPS policy statements that reinforce our commitment to diversity and inclusion.

COMMONS ROOMS, DEPARTMENT HEALTH, AND IDENTITY

We know that successful SPS chapters create unity among students through consistent events and activities, but where do fellow students gather just to study or work on projects together? Though campus libraries and local cafés can be welcoming, they tend to lack the physical resources and faculty presence that can benefit physics students. Besides, these locations may discourage group collaborations, especially noisy ones that require a lot of space or equipment. After reading a number of SPS chapter reports, we began to see a solution emerge: A common room specifically for physics students. The more we explored the idea of common rooms, the more we realized just how much they can contribute to a physics department and the success of its students.

First, a physics common room facilitates communication between faculty members and students who may find it difficult to interact outside the lab and lecture hall. With a designated common room, faculty can provide supplementary course help and informal and formal mentoring, and students can take advantage of networking opportunities through study sessions, alumni talks, and other events.

Second, common rooms can be equipped with tools that are useful to physics students and that may not be available in general campus spaces. Readily available whiteboards, physics literature and journals, and computers with necessary programs are just a few of the resources that can attract physics students to these lounges. They may also have engaging physics toys, research equipment, and spaces in which students can leave works-in-progress.

Finally, physics common rooms nurture engagement, functioning as a forum where physics students discuss all kinds of topics, both formally and informally. They provide a landing place—a reason to meet up after class, study together, build friendships, unwind, and welcome new physics majors, all of which can keep students encouraged and inspired along their physics journey.

While this is helpful for encouraging overall student involvement, it is particularly relevant for SPS chapters. When SPS leaders know what their members want, they are better equipped to design successful, enjoyable events and seek relevant resources. This community involvement may also encourage newer members to seek leadership roles in the chapter.

The overall health of a physics department relies on strong communication and collaboration between its members. In light of this, in early 2019 the SPS National Council voted to adopt the following statement in support of common rooms.[1]

TOP: Chloe Ong.
ABOVE: Megan Anderson.
Photos courtesy of SPS National Office.

SPS Statement on Commons Rooms, Department Health, and Identity

"The Society of Physics Students (SPS) recognizes that a physics commons room or physics lounge encourages community and provides a space for learning. Physics and astronomy students, faculty, and guests benefit from a dedicated place for discussion and discovery. Access to a commons room empowers undergraduate students in their studies while also promoting collaboration. SPS is committed to providing resources that support and highlight student commons rooms. We encourage other groups within the physics and astronomy community to create student commons rooms with the goal of nurturing our physics communities."

No matter their budget or size, a physics department can and should invest in some version of a student commons room—a space for physics students. If your department lacks square footage, think creatively. A single table, some chairs, and relevant literature can be enough to give students a sense of belonging.

DIVERSITY, INCLUSION, ETHICS, AND RESPONSIBILITY

The discussion of physics commons rooms naturally leads to a discussion about the importance of diversity and inclusion within departments and SPS chapters. These are ideals that many people value yet struggle to fully realize, a reality that SPS also faces. In 2016, the SPS National Council approved two statements on diversity and inclusion that focused on making physics more accessible to everyone and physics gatherings welcoming to all. The new statement, also adopted by the SPS National Council in early 2019, partners with these statements, providing more concrete guidelines pertaining to the ethical behavior of SPS members. The SPS National Council hopes that this new statement serves as a resource for chapters and individuals seeking to nurture and grow our community.

SPS Statement on Diversity, Inclusion, Ethics, and Responsibility

"The Society of Physics Students (SPS) welcomes all students with a passion for physics independent of identity, regardless of but not limited to race, ethnic origin, religious beliefs, gender, gender identity, sexual orientation, disability, age, family and socio-economic status, or cultural background. Many groups are under-represented in physics, and SPS and Sigma Pi Sigma have not always been welcoming to diverse groups. Today all our events are subject to our Code of Conduct,[2] and SPS and Sigma Pi Sigma are committed to working to correct this exclusion and will continue to update our policies and best practices in pursuit of promoting diversity, inclusion, and equity."

To learn more about how to make commons rooms welcoming to all, see the article on page 16, *Fostering Inclusive Physics Spaces*.

On behalf of the Governance Committee, thank you for taking the time to invest in the growth and strengthening of this organization. Together we can create spaces for physicists of all identities to come together in community and feel welcome. //

References:

1. Additional information on the benefits of student common rooms can be found at https://www.compadre.org/JTUPP/docs/J-Tupp_Supplement.pdf.
2. To read SPS and Sigma Pi Sigma's Code of Conduct, please visit https://www.spsnational.org/code-conduct.

Why Failure Should Be an Option

by Ari Diacou, Attorney at Law

ABOVE: Ari Diacou. Photo courtesy of Ari Diacou.

I love failing. When I went to law school, the first paper I wrote for a class got a 17/100. Despite my career as a professional writer, my writing was apparently terrible. Why did I go to law school? Because patent examining didn't work out. How did I get into patent examining? Because I didn't end up going for a PhD, like I always assumed I would.

I have literally lost count of how many times I've had stitches, and I can tell you with absolute certainty that you should not use your front bicycle brakes while going down a hill. Also, don't ride your bike over a street grate parallel to the openings, don't look up to talk to a friend while using a knife, and if you're playing catcher in baseball, wear knee pads—or at least check for glass around home plate.

I certainly would have preferred not going to the hospital to learn those lessons, but c'est la vie.

I've found that failing is the most effective way to learn a new skill. If you're reading this, I assume you're a physicist, like me. We're a smart bunch and most likely have had many years of academic success. But if you've succeeded at everything, how much did you put yourself out there? While a 4.0 GPA is commendable, it might also reflect a lack of academic challenges.

Failure is a part of life, necessary to build confidence and a sense of self. It either indicates what you (currently) can't do well or is simply the null result of an experiment you undertook. Life is a series of experiences—facing the universe, making some choices, and hoping it works out. Each experience is an experiment, but it's not about arriving at the final answer, it's about filling up the lab notebook.

The ancient Greeks defined hubris as the assumption that everything always works out, and the playwrights punished their protagonists heavily for such a sin—all to point out that you will, inevitably and despite your best efforts, fail spectacularly. So if, according to the Greeks, you're going to fail anyway, why be surprised when it happens? Put failure in your learning toolbox. Seek out situations where you can fail safely.

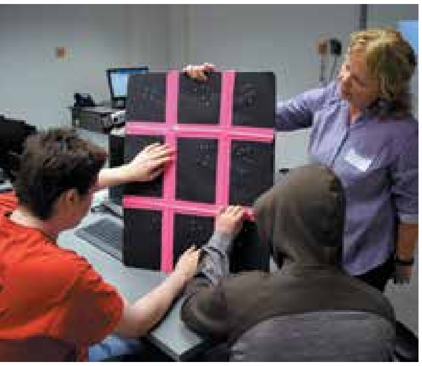
If you're anything like me, failing will put you in a position to succeed at things you're unfamiliar with, and you won't freak out if you have to learn a second (or 14th) programming language or decide to quit your job to become a lawyer.

Ari Maynadier Diacou is a physicist, lawyer, and nerd. After nine years at the US Patent and Trademark Office—where he examined optical amplifiers, LIDAR, and acoustic sensors—he decided he wasn't going to retire as a bureaucrat and took up night school at the Catholic University of America. He works in DC as an attorney and lives near his alma mater in College Park, Maryland. The bike trail behind the headquarters of SPS National is his favorite spot inside the Beltway. //

SPECIAL FEATURE

Developing a Feel for Astronomy

by Korena Di Roma Howley



TOP: Kathy Gustavson, a retired physics teacher and IDATA curriculum developer, uses a tactile model developed by the IDATA team to teach participants from the Wisconsin School for the Blind how a charge-coupled device camera works, enabling them to help with software design. Photo courtesy of Kate Meredith, GLAS Education.

ABOVE: Elena Charles, an IDATA participant from the Wisconsin School for the Blind, helps Kate Meredith understand how astronomy software interacts with her new BrailleSense notetaker. Photo courtesy of Kate Meredith, GLAS Education.

In October 2018, the closure of the historic Yerkes Observatory in Williams Bay, Wisconsin, could have meant the end of its ongoing projects, including a research initiative aimed at improving astronomy tools and education for the blind and visually impaired (BVI).

But Kate Meredith, the director of education at Yerkes, wasn't ready to suspend her efforts at making astronomy more inclusive and accessible. She and a colleague struck out on their own to continue the mission of Yerkes Education Outreach, creating Geneva Lake Astrophysics and STEAM (GLAS). Though unaffiliated with Yerkes or the University of Chicago, which owns the observatory, GLAS initiatives are still deeply rooted in the work Meredith started there.

One of these projects is Innovators Developing Accessible Tools for Astronomy, or IDATA. A three-year project funded by the NSF, the IDATA program employs user-centered design to develop software that makes astronomy accessible to everyone, in part by converting numerical data into "vision-neutral" tools. Collaborators include high school students and teachers, software engineers, and professional astronomers.

"We have to work on the [current] software, because it isn't allowing equal access to information," says Meredith, a former biology teacher who became passionate about astronomy after stepping in to teach a class on the subject.

Naleah Boys, a sighted tenth grader at Wisconsin Connections Academy, has been with the program for three years. "When I began IDATA, like most of the population I thought of astronomy as a visual field," she says. "During IDATA I learned that humans are the ones who made it visual. When we take a picture using a telescope, we turn the numerical data into something that most people can understand and interpret. This was something that completely reshaped my view of astronomy."

Meredith believes astronomy benefits from input by those who have different ways of looking at problems and data. She points out that the contributions that blind students have made to the development of the IDATA software can't be replicated. "That is a wealth of creativity and skill that we would be well advised to include," she says.

For budding BVI astronomers, tools like IDATA offer an entry point to the universe and an opportunity to experience astronomy firsthand. This was a goal Dr. Ana Larson had in mind when she led the development of a five-day lesson plan for BVI middle school students in Washington state. Working with graduate and undergraduate students at the University of Washington, Larson—now a lecturer emeritus in astronomy at UW—enlisted the help of blind students to test the lesson plan and make suggestions.

Larson was inspired by an experience she had in 2006 during an on-campus event hosted by UW's Space Grant program. The event included sight-impaired students, and Larson recalls a young woman who viewed the star Vega through an early refracting telescope in the school's Theodor Jacobsen Observatory. "She saw a star for the first time in her life and was ecstatic, as were the rest of us in the dome," Larson says. "That inspired me to think more about how that telescope was perfect not only for viewing but also because all of its parts are accessible: the drive, the finder scope, the knobs that control its pointing, the hour angle and declination wheels, and more. Literally, hands-on."

The curriculum Larson and the students developed incorporates hands-on activities—including a "space walk" that uses a scale model of the solar system—and employs specially developed reading materials, such as books by author Noreen Grice, who has published nearly a dozen astronomy materials geared toward BVI readers. These include a series of Braille books (*Touch the Stars, Touch the Sun*, and others) that enable a tactile exploration of the constellations, celestial bodies, and NASA multiwavelength images.

While the curriculum hasn't yet been incorporated into schools, Larson says feedback, including from students who tested the lesson plan, has been positive.

For Meredith, continuing to serve the blind community in and around Williams Bay, which includes the nearby Wisconsin School for the Blind and Visually Impaired, is about education, inclusiveness—and fun. Local programs, for instance, include hack weekends and star parties, and Meredith says they're looking to develop an accessible astronomy playground through user-centered design. "We just make sure that the idea of having an immersive experience is still alive here," she says. //

Standing Out When Applying to a Graduate Program

by Brad Conrad, Director of SPS and Sigma Pi Sigma, and Matthew Wright, Associate Professor and Department Chair, Adelphi University

The application process for graduate physics programs can be intimidating, so in this article we'd like to offer some suggestions and guidance. Note that our experience is primarily with physics and astronomy programs in the United States and Canada, but the application processes for other fields and programs in other countries are often similar. Keep in mind that our suggestions are just that—suggestions. The more people you hear from, the better.

Graduate programs generally examine lots of documents and consider many factors during the application process: letters of recommendation, personal statement(s), course performance, quality of undergraduate preparation, research experience, areas of applicant interest, and personal characteristics. Ultimately, admissions committees are looking for students who will excel, be excellent researchers for their faculty, raise the profile of the university, and contribute to the department. Departments want students that interact well within the department, have resolve, can teach undergraduate courses, and can pass their exams into candidacy. Each component of an application can help you stand out to the admissions committee as they evaluate these criteria. The following list is roughly ordered in terms of importance, but you should ask other professors and colleagues their opinions.

PICK THE RIGHT SCHOOLS FOR YOU

Apply to the best schools for you, not just the ones you've heard of. Many schools have areas they excel in. Focus on individual professors and groups to work with, not the school's rank. Spend some time thinking about what your goals are, what you hope to get from a PhD, what you would like to do when you finish, and your ideal work environment. This can be tricky, but you can learn a lot by going to GradSchoolShopper.com (for comparable data), reading university websites (to get a sense of who they are), looking at research group papers (to see if these research topics interest you), and talking to your undergraduate advisers. Get LOTS of opinions, and ask the hard questions.

The people side of the equation is important too. Spend time networking and engaging in social media where available. Your PhD adviser could be one of the most influential people in your adult life, setting the tone for your graduate experience and serving as a primary contributor to your professional network while you establish your career. Be sure to communicate with likely advisers. Discuss work styles, expectations, group graduation times, funding, and research interests.

UNDERGRADUATE DEGREE AND GPA

You don't necessarily need a degree in physics to be admitted into a physics or astronomy PhD program, but it can be challenging to succeed without one, as the pace is fast and expectations are high. Most schools have a minimum GPA requirement to receive financial support, with a 3.0 or higher being a common cutoff. Pragmatically, you should aim for a higher GPA to be competitive. Admissions committees will look at what courses you've taken (physics, mathematics, etc.) and your grades in those courses. These factors matter a lot more than your undergraduate institution. They want to know if you are prepared and what you need to work on.

PERSONAL STATEMENT AND APPLICATION

Admissions committees often spend a good deal of time reading your personal statement, as it can be a clear window into many of the factors they are looking for. Rather than use a generic statement, directly answer any prompts they provide and avoid providing a laundry list of research areas. Instead, highlight why you're a good fit for the program and why it's a good fit for you. Customize your application to the specific program, faculty, and research areas you're focusing on. Keep in mind that your personal statement will most likely be read first and could impact how your other materials are viewed.

LETTERS OF RECOMMENDATION

Many schools ask for multiple letters of recommendation, and for good reason. Some consider these to be the most important part of the application. Request letters from people who can provide a well-rounded picture of who you are and why you would succeed in graduate school. You need someone to speak to your coursework performance and your research skills. Make sure they can speak to how you would work in a research environment. Faculty who have taught you in multiple courses and those you've done research under are ideal. Always provide letter writers with a copy of your C.V. to help them write about your accomplishments.

RESEARCH, OUTREACH, AND LEADERSHIP

One of the most important factors committees look for is your ability to conduct guided and independent research. Highlight the skills and experiences that *show* the committee you are prepared to do these activities as a graduate student. Providing examples of your research and leadership is typically better than listing them. Students often think that the more things you do as an undergrad the better chance you have to succeed. However, for the personal statement, it can be advantageous to pick a single project and dive into it. It doesn't matter if your undergraduate research project or internship doesn't align with what you ultimately want to study in graduate school. The project depth and skills acquired are what matters. Additionally, highlight when your work has been featured in publications, presented

at conferences, or received awards. (The Society of Physics Students and other Member Societies provide funding to help students attend professional conferences such as the American Association of Physics Teachers, which always has an undergraduate-friendly setup.[1] Going to these conferences can also be an excellent way to network.)

START THE PROCESS EARLY

Some programs accept applications as early as one year before admission. Becoming familiar with due dates and required materials for each department is vital, but also keep in mind that it usually costs money to apply to a program. Also note that you can sometimes get it waived by contacting the graduate department and asking. Apply only to those programs that fit you, your interests, and your needs. Students who are serious about the process often apply to multiple programs—five to ten programs is not uncommon.

GENERAL GRE AND SUBJECT TEST

Graduate programs usually require the standardized GRE general test and sometimes require the physics subject test as well. A poor performance on one or both does not mean you won't do well in a graduate program, but it may limit your options. Check the requirements of the programs you're interested in, the dates and locations where the GREs are offered, and begin studying as early as possible. A good strategy is to mimic the testing atmosphere with practice tests. For more on the GRE, see page 25.

OTHER THINGS TO CONSIDER

While preparing your graduate school admissions material it can be beneficial to also apply for fellowships, such as the NSF graduate fellowship.[2] If you are awarded one, it can be a powerful tool, giving you resources to focus on research and coursework.

Many qualified students decide not to apply to graduate school because of a wide variety of barriers:

- Application costs
- Perception that GRE scores aren't good enough
- Unclear GPA requirements or expectations for the application process
- Lack of research or course experience
- Imposter syndrome (feeling of self-doubt or inadequacy)

Before you make that decision, consider that while admissions committees consider a variety of metrics, they are ultimately looking for people who will succeed in their program and connect well with their faculty. If you have extenuating circumstances that describe less-than-stellar grades, poor test scores, gaps in your education, or another potentially problematic aspect of your application, consider addressing that in your personal statement or ask your mentors whether it makes sense to mention it in your letters of recommendation. Grit and the ability to overcome challenges matters to lots of admissions committees.

Many of the people applying to a given school could academically succeed in their program, thus graduate programs want to offer admissions to students who truly want to be there and will accept if offered. To truly stand out in your application, let your passion and personality shine through.

Remember, talk to faculty and other professionals about their experiences and recommendations, as subfields and departments will vary. When in doubt, **ask the Graduate Program Coordinator of the program you are interested in.** Do keep in mind that if you're looking at schools and programs in Europe, the process and expectations may differ, so be sure to do your homework before applying.[3]

While most programs have a similar set of expectations for graduate study, **admissions committees will vary** considerably by institution and sometimes by subfield, as faculty rotate on and off the committee. Additionally, while many programs make the recommendation on whom to admit, graduate schools often make the final offer for admittance. When writing, focus on communicating to faculty within the department you are applying to. **Keep in mind that what makes you stand out to one program might not be as noteworthy to another. Your best course of action is to personalize each application to showcase who you are and what makes you a good fit for that specific program.//**

References

1. https://www.apsbridgeprogram.org/.
2. https://www.nsfgrfp.org/.
3. https://astrobites.org/2014/06/13/how-to-apply-for-grad-school-in-europe/.

Real Talk: GRE Scores and Physics Graduate Programs

by Kendra Redmond, Editor

As part of the admissions process, many graduate programs in the United States require students to take the standardized Graduate Record Examination (GRE) general test. The "general GRE" includes sections on verbal reasoning, quantitative reasoning, and analytical writing, and test takers receive a numerical score in each area. Many physics graduate programs also require students to take the standardized, subject-based physics GRE. Physics GRE test takers receive a single numerical score.

But what do the scores actually mean? If you score low, should you start applying to jobs instead of graduate programs? If you score high, does that mean you'll be a tenured physics faculty member in no time?

A team led by Casey Miller, a PhD physicist and associate dean for research and faculty affairs at Rochester Institute of Technology, recently analyzed 10 years of student data to find out whether GRE scores—verbal reasoning, quantitative reasoning, or physics—predict successful completion of a physics PhD. Their results were published in January in the journal *Science Advances*.[1]

Q&A WITH CASEY MILLER

What is the "bottom line" finding of your study?

GRE scores do not predict success in PhD physics programs very well.

What should physics students know about the GREs?

A GRE score does not reflect your potential to be a PhD-level scientist. There is much more to graduate education. As a result, students who score low can, and often do, become excellent scientists. Students who score high can, but do not always, make excellent scientists.

What is the problem with using GRE scores as physics grad program admissions criteria?

The main problem is when programs use the scores in unenlightened ways to select who gets to do the science of the future. For example, some require a minimum score for admission. This is not in line with how the test maker says to use the test. This practice significantly biases who is deemed "acceptable," and it is especially damaging to the representation of applicants who identify as female, Hispanic, Native American, African American, and US citizens.[2] Combine that with our results that question the tool's utility, and you have a serious systematic problem.

What would you say to a student who takes the physics GRE and does poorly?

Your score is not necessarily related to your ability to do PhD-level physics or to become a PhD-level scientist. But because of the misuse of GRE scores in the admissions process, you will be overlooked by certain programs—at their loss.[3]

What would you say to a student who takes the physics GRE and does well?

Your score is not necessarily related to your ability to do PhD-level physics or to become a PhD-level scientist. Completing a PhD requires numerous skills that cannot be measured by such tests.

What advice would you give to students applying to physics grad programs?

Consider programs based on multiple dimensions, including non-science-specific issues such as culture and location, to make a best guess about how well they might fit your life.

References

1. Miller, C. W., et al. Typical physics Ph.D. admissions criteria limit access to underrepresented groups but fail to predict doctoral completion. *Science Advances*. 2019 Jan. 23: 5(1). DOI: 10.1126/sciadv.aat7550.
2. Editor's note: Research reveals that standardized GRE tests show significant gender and race-based differences. As Miller et al. write in the paper, "Although the best evidence suggests that faculty are well intentioned when selecting students, many are unaware of demographic patterns in GRE scores and they carry out admissions according to inherited practices that include using cutoff scores. Programs using the [physics GRE-P] as an integral part of their admissions process may be unwittingly selecting against underrepresented groups and U.S. citizens."
3. Editor's note: If you find yourself in this situation and would still like to be considered by a program that uses a cutoff, you can retake the general and physics GREs. Utilizing GRE prep materials may help you improve your scores. Alternatively, you may want to explore programs that do not require the GRE, a criterion that can be selected for on https://www.gradschoolshopper.com.

Yearly Calendar for SPS Chapters

There is no standard program for a SPS chapter because each chapter is unique. This calendar provides a guide for activities and programs your chapter may wish to consider throughout the academic year. Not every chapter will choose to engage in every element. Choose those that work best for you!

BEGINNING OF SEMESTER:

- Membership Drive: Participate in Freshman Orientation Program to acquaint freshmen with SPS. Have a booth to encourage bulk registration for national membership.
- Visit introductory physics classes
- Put up SPS posters and meeting announcements
- Request the SPS outreach kit (SOCK)
- Plan biweekly meetings for the year

SEPTEMBER:

- Kick-off social (Ex. faculty-student picnic or other get-acquainted event)
- Fundraisers: Sell books donated by faculty, used textbooks, bumper stickers, chapter-designed T-shirts, raffle tickets, car wash, etc.
- Plan for big events and outreach: Marsh W. White Award, Future Faces of Physics Award, and Sigma Pi Sigma Undergraduate Research Award proposals, brainstorm outreach events
- Post fall mailing materials
- Collect dues and fill out group membership forms for discount

OCTOBER:

- Talk by outside lecturer at meeting
- Bad physics movie night
- Attend SPS Zone Meeting or plan to attend regional meeting
- Arrange to attend a national research meeting
- Hold a fundraiser for PhysCon
- Halloween-themed physics event
- Check out SPS outreach demos or create your own to upload on the website
- Ask your AZC* and ZC* about the next zone meeting

NOVEMBER:

- Submit chapter proposal for Marsh W. White Award & Future Face of Physics Award
- Submit student proposals for SPS Chapter Research Award
- Host an outside speaker/ lecturer at monthly meeting
- Tour of physics/astronomy research laboratory (industrial, government, or academic)
- Submit chapter proposal for Sigma Pi Sigma Chapter Project Award
- Thanksgiving potluck

* AZC/ZC are your associate zone councilor and zone councilor that represent your zone at the SPS National level.

DECEMBER:

- Business meeting: Nomination of chapter member as candidate for associate zone councilor
- Program planning for spring social event (set date, budget, etc.)
- Host a year-end party
- Identify a spring tour at a nearby lab or facility

JANUARY:

- Submit student applications for SPS summer internships
- Plan chapter road trip
- Prepare a member outreach event
- Hold fundraising event for spring events

FEBRUARY:

- Arrange a talk by faculty member at monthly meeting
- Host a bad physics movie night
- Submit SPS Scholarship applications
- Apply for SPS and ΣπΣ service awards

MARCH:

- Talk by outside lecturer at monthly meeting
- Tour of physics research laboratory (industrial, government, or academic)
- Sponsor physics department open house
- Business meeting: Cast chapter vote in SPS elections
- Attend SPS zone meeting
- Submit SPS Scholarship and Outstanding Undergraduate Research applications, and Outstanding Chapter Advisor nominations
- Submit research and scholarly reports for publication in JURP

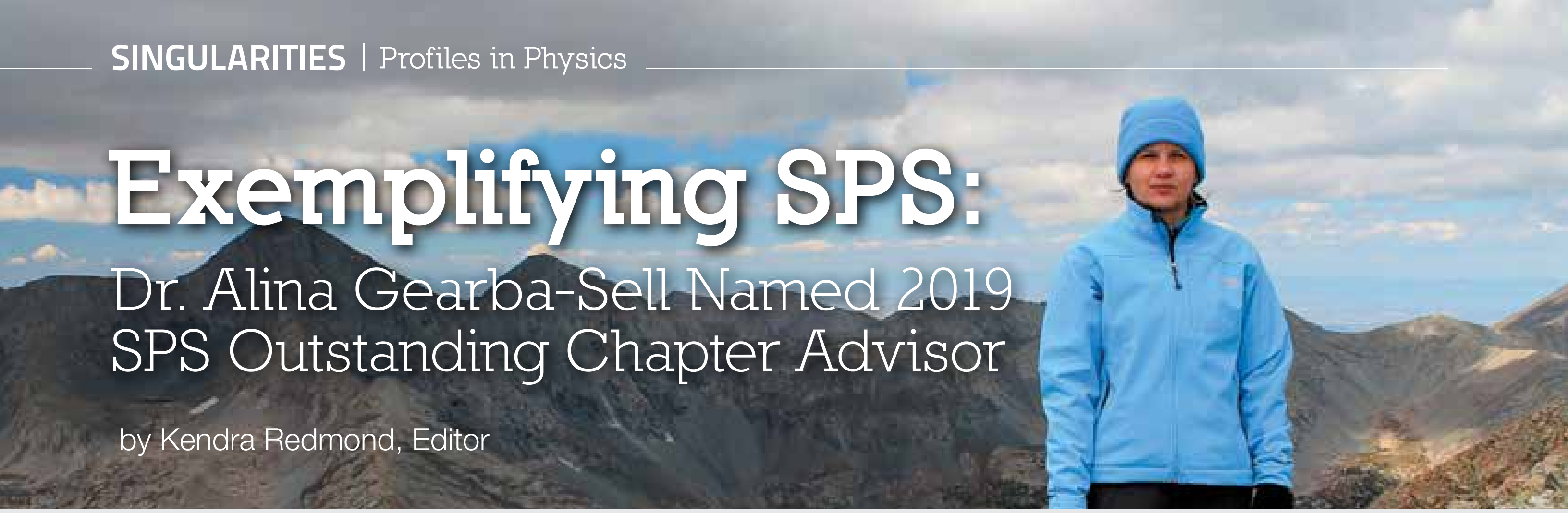
APRIL:

- Sigma Pi Sigma reception, talk, and induction banquet
- Talk by outside lecturer at monthly meeting
- Business meeting: Election of chapter officers for next academic year, preliminary planning for chapter program for next academic year
- Submit new officers to SPS National database
- Business meeting: Nomination of chapter officers for next academic year
- Find a creative way to thank and celebrate your SPS advisor

MAY:

- Large social event: faculty-student picnic and soccer game
- Submit Chapter Report before everyone leaves for the summer and apply for Blake Lilly Prize
- Plan a fall meeting date to start off the new year
- Celebrate graduating seniors
- Develop goals for next year
- Email the new AZC and ZC to introduce your SPS chapter and officers

ABOVE: SPS advisor Paul Gueye (to the left of the door) and the Hampton University SPS chapter. Photo courtesy of Brad Conrad.



Exemplifying SPS:

Dr. Alina Gearba-Sell Named 2019 SPS Outstanding Chapter Advisor

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 their chapter.

For her leadership and guidance of the SPS chapter at the United States Air Force Academy and previously at the University of Southern Mississippi, Dr. Alina Gearba-Sell is the 2018–19 SPS Outstanding Chapter Advisor.

ABOVE: When she's not working, Gearba-Sell enjoys hiking in the Rocky Mountains.

BELOW: Students from the USAFA SPS chapter pose with Gearba-Sell during a meeting. Photos courtesy of Alina Gearba-Sell.

As a new faculty member at the University of Southern Mississippi, Alina Gearba-Sell was assigned the role of SPS advisor. Her first response: What is SPS?

Gearba-Sell had never heard of SPS, having completed her education at the Polytechnic University of Bucharest in Romania, but she tackled the question with the curiosity and enthusiasm of a physicist. Now an advisor for more than 15 years, she has not only been sharing the answer with students but helping to shape it as Zone 10 councilor and currently as president of SPS.

At her current institution, the United States Air Force Academy (USAFA) in Colorado, Gearba-Sell has cultivated an SPS chapter where students are comfortable, supported, and equipped to reach the next level of professionalism and skill. "I found my first home at USAFA in the physics department," wrote the student who nominated Gearba-Sell for the Outstanding Chapter Advisor Award. "Dr. Gearba-Sell's leadership has helped to foster a familial, positive environment that our members have come to love and expect from one another."

When she arrived at USAFA five years ago, the physics department had an SPS chapter whose primary focus was local outreach. Under Gearba-Sell's leadership, the chapter expanded their activity by establishing a Sigma Pi Sigma chapter, applying for and receiving four awards from SPS National, publishing papers in science journals, hosting a zone meeting, and attending conferences such as the Sigma Pi Sigma Physics Congress and the American Physical Society (APS) Conference for Undergraduate Women in Physics. The group has earned the "Outstanding SPS Chapter" designation every year since her arrival.

One student describes the change this way: "Dr. Gearba-Sell has revitalized and transformed the chapter . . . She has helped our chapter establish a vision that prioritizes expanding outreach beyond the local area and creating meaningful professional connections between cadets and mentors, both fellow students and working physicists."

Engaging students in this level of activity is challenging, admits Gearba-Sell, especially at a school where all of the students are busy with classes, military activities, and athletic requirements. But SPS offers students crucial opportunities to develop as physicists, she says. She sees her role as connecting students to these opportunities and providing support and guidance along the way. "Take advantage," she advises students. "Join SPS National, APS, and the National Society of Black Physicists or National Society of Hispanic Physicists. Make as many contacts as possible. You never know where your next opportunity is going to come from."

According to Gearba-Sell, one of the keys to being a great SPS advisor is getting to know the chapter and the needs and passions of individual students—then pointing them in the right direction. She takes this approach to teaching too. "There are so many different teaching methodologies now," she says. "You have

to see what resonates with your students, and you have to find what motivates them, engages them, and helps them succeed. When you tailor your teaching style to create meaningful learning experiences for your students, you foster a transparent, respectful, and trusting learning community."

In addition to advising and teaching, Gearba-Sell has an active lasers and optics research lab and regularly works with students on experiments, seeks external funding, publishes papers, and gives presentations. She has received awards for research excellence, has won "Civilian of the Year," and has accompanied students on a cultural immersion trip to Switzerland. As SPS president, Gearba-Sell is gearing up for the 2019 Physics Congress in Rhode Island, working on a proposal for officially recognizing SPS students who have made significant contributions to strengthening their chapters, and brainstorming ideas for the 2021 Centennial of Sigma Pi Sigma. "It's busy, but I enjoy every minute of it," she says.

So, what is SPS? In the fall 2018 issue of the *SPS Observer*, Gearba-Sell wrote, "SPS is an undergraduate's first professional society and, in many cases, their first physics community. Through local impacts and national initiatives, SPS provides professional development, networking opportunities, and last, but not least, a sense of belonging." For bringing this definition to life for so many students, Gearba-Sell will be recognized at the Winter Meeting of the American Association of Physics Teachers as the 2019 SPS Outstanding Chapter Advisor. //

ABOVE: Gearba-Sell while visiting CERN with students during a cultural immersion trip to Switzerland in 2017. Photo courtesy of Alina Gearba-Sell.

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The ABCs of ICPS:

An Alphabetical Guide to the International Conference of Physics Students

by Megan Anderson, William Jewell College, 2018–19 SPS Executive Committee Member, Associate Zone Councilor Representative

ABOVE: The ICPS 2019 group photo taken in the Cologne City Hall where participants were welcomed by the mayor of Cologne. Photo courtesy of Stefano Ugliano.

Thanks to SPS, I traveled over 4,500 miles (7,242 kilometers) this past August to represent the United States at the International Conference of Physics Students in Cologne, Germany.

Technically, though, my journey began a little over a year ago when I was elected to the associate zone councilor (AZC) position for Zone 12. This meant that I would sit on the SPS National Council, supporting and representing SPS chapters in Kansas, Missouri, and Oklahoma. My fellow AZCs then elected me to be their representative on the Executive Committee. Since SPS is a member of the International Association of Physics Students (IAPS), one of my associated duties was serving as the IAPS United States delegate.The bulk of the work takes place during the International Conference of Physics Students, an event I explain alphabetically below.

A: Acronyms — The main one you need to remember is "ICPS," which stands for the International Conference of Physics Students, a yearly gathering with about 500 (you guessed it) physics students. This is the largest and most anticipated event organized by the International Association of Physics Students (IAPS).

B: Booklet — An informational treasure trove given before the conference that has the answer to just about every logistical question you could ask.

C: Cologne Carnival — An annual festival in Cologne, Germany, that includes costumes and celebrations. The main events occur in late fall and early spring, but the fantastic 2019 Organizing Committee made it possible for me and the other ICPS attendees to enjoy some of the festivities during one summer night of the conference.

D: Dancing — It happens at many of the ICPS social evenings! We learned a few formal steps at the introductory workshop on Sunday night, but it turns out that classics such as the YMCA and Macarena transcend national borders. During Carnival Night, a spontaneous conga line even formed!

E: Elephant — The adorable mascot of the German Physical Society. See letter G.

F: Fifty — The approximate number of countries represented at ICPS 2019.

G: German Physical Society — With over 60,000 members and a 174-year history, the German Physical Society (DPG) is the oldest and largest organization of physicists in the world. Student members of this society served as the ICPS organizers this year.

H: Happy — The feeling you get when surrounded by hundreds of students from around the world who care about physics as much as you do.

I: International — The word that comes up over and over again in conversation, both explicitly as you discuss IAPS and ICPS and more subtly as you talk with people from countries largely unknown to you.

J: Jokes — The only way you'll survive the Annual General Meeting, an event full of tedious legal proceedings and international cooperation. Only delegates are required to attend, but a few other brave souls may join in solidarity.

K: Klaus von Klitzing — A Nobel laureate whose work helped redefine the kilogram. He was an ICPS plenary speaker and an excellent storyteller. He shared about his initial work on semiconductors, discovery of the integer quantum Hall effect, and accidental entry into the world of measurements as well as humorous observations regarding the scientific community (for an example of this, search "NASA vs ESA excitement level").

L: Languages — You'll be surrounded by people who speak many different languages, though English is the official language of the conference. Lucky us!

M: Mexico — The location of next year's ICPS. (It's the first time ICPS is taking place outside Europe, which makes it much more convenient for US students to attend ICPS 2020!)

N: Nations Evening — The social event everyone eagerly anticipates, where students make and share traditional foods from home. It's like speed dating but with countries.

O: Overwhelmed — The feeling you get when walking around the tables during Nations Evening. But it's a, "What amazing thing will happen next?" kind of overwhelmed.

ABOVE LEFT: Accommodations for ICPS were located within walking distance of the Cologne Cathedral, right across the Rhine River. Photo courtesy of Megan Anderson.

ABOVE RIGHT: Who would've thought that peanut butter and jelly sandwiches could require explanation?! Thank you to Mohammad Moosajee for capturing this moment and helping make this mountain of sandwiches. Photo courtesy of Megan Anderson.

P: PB&Js — The edible fare provided by the US contingent at Nations Evening.

Q: Questions — Keep asking them! When else will you be surrounded by people from so many different backgrounds and with so many different specialties and perspectives?

R: Reflect — Conversations naturally led me to reflect a bit more on my experience as a physics student, young researcher, and US citizen. I used part of the plane ride home to journal about these reflections, and I suspect I'll continue to process them in the months to come.

S: Support — Something you begin to feel as strangers become friends.

T: Talks — You'll have the opportunity to go to lots of these, from those given by student speakers to presentations by established physicists (refer back to K).

U: Umbrella — What you carry around for days on end because the forecast keeps playing with the idea of rain.

V: Vote — What you do if you're a delegate at the aforementioned Annual General Meeting. During the year, the delegate responsibilities are mainly confined to communicating with their regional or national organization and attending periodic online meetings hosted by the IAPS Executive Committee. Then comes ICPS, when all of us delegates spend hours upon hours reading through governing and regulatory documents, proposing and discussing amendments, and voting on all proposed changes as well as membership motions.

W: Water — Be warned: Europeans love drinking sparkling water and, incidentally, may forget to mention to you that virtually every bottle of water they provide is carbonated.

X: Xenial — The atmosphere of the conference. (I may or may not have learned this word just to have a good "x" entry, but it's actually quite fitting! It essentially means "friendly.")

Y: Yes — The word that leads to spicy Chinese noodles, a dance lesson with a Hungarian, collaboration with a Croatian, and everything in between.

Z: Zzzzs — Don't expect to get many of them! But don't worry—you can catch up after the conference and be ready to go again next year! //

Want to experience this for yourself? Go to scj.org.mx/icps/ for information on ICPS 2020!

Are you interested in serving on the SPS National Council? Learn more at spsnational.org/about/governance/national-council. Elections are in the spring!

STEP-ping UP and Networking at AAPT

by Amber Sammons, 2019 SPS/AAPT Teacher Professional Development Intern and SPS Member, Illinois State University

Mountains do, in fact, exist. That was the first thing I learned when I landed in Provo, Utah, for the summer meeting of the American Association of Physics Teachers (AAPT). The unfamiliar formations (I'm from the prairies of Illinois) set the tone for a week filled with new experiences and discoveries.

At the time of the meeting, I was an SPS summer intern working with AAPT. Because of this, I was able to access a bit more of the meeting than I had when I attended previous AAPT meetings. In particular, I had the opportunity to visit some of the workshops that AAPT hosted for physics teachers, which expanded my knowledge base as a physics teacher in training.

Before the official meeting started, I helped prepare the K-12 Teacher's Lounge, a place where various workshops were held to provide digital resources, topical discussions, and interactive labs and lesson plans. The person who was in charge of running the lounge happened to be someone who previously held my internship position. Since then, she has changed from being a high school physics teacher to a science coordinator for an elementary school. While my passion and career goals lie in teaching high school physics, it was great to talk to her about her journey and hear the advice she had for people interested in working with younger students.

After the workshops and setup ended, the conference officially began. My physics education research team from Illinois State University was also attending the meeting. While I wasn't able to present our research, I helped my team prepare data and write papers throughout the summer. Our group presented two posters and a talk during the conference, all of which I helped with in some capacity. Another highlight of the meeting was networking with people who were introducing new resources and teaching methodologies to the classroom, either at the K-12 level or the introductory college level. Over the course of the conference, I made connections with people from NASA's Jet Propulsion Laboratory, professors doing research at universities across the country, and even possible graduate schools.

ABOVE: Amber Sammons. Photo courtesy of SPS National Office.

BELOW: AAPT attendees at the summer picnic held on the campus of Brigham Young University. Photo courtesy of AAPT.

The biggest takeaways from the meeting were the connections I made and the lessons I learned from STEP UP (a national movement that provides resources to reduce barriers and engage young women in physics) and other groups supporting women pursuing physics degrees and/or careers. I have been working to start a Women in Physics group at my university with limited support. Luckily, we were awarded a grant from APS to help with this endeavor financially, but the process of starting a new group on campus is challenging. I had an extended conversation with a group from the University of Maryland about ways to make sure this sort of club survives and thrives, and I attended a STEP UP session that demonstrated that there really is a movement to improve the experience of *everyone* pursuing physics. The session talked specifically about lesson plans STEP UP has developed and their work helping women develop physics identities. It gave me so much courage as a preservice teacher to see meaningful and important lesson plans that have been easily implemented and successful. This experience has reinvigorated my pursuit of a Women in Physics group at Illinois State and my goal to encourage the students in my future classes to see themselves as physicists. //

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