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Brittney Hauke
Graduate Researcher
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ON THE COVER
Colorado Mesa University SPS chapter’s 13th annual pumpkin drop. Photo courtesy of SPS National.
Engaging with Your Community
by Brad R. Conrad, Director, SPS and Sigma Pi Sigma

Sigma Pi Sigma was founded in 1921, and I would like to think that its founders would have been pleased to see how the linked societies we know today as Sigma Pi Sigma and the Society of Physics Students have spread widely and yet remained focused on supporting the next generation. The society’s founders at Davidson College’s alpha chapter, its original label, included both faculty and students. This sense of shared ownership between students and professionals permeates the way we continue to govern ourselves and are supported by the American Institute of Physics. Through national elections, the physics congresses, and a strong collaboration with professional societies that Sigma Pi Sigma members can participate in, the society remains relevant and connects us together as lifelong physical scientists.

A lot has changed within the community over the past 98 years. Physics, the way we learn physics, and Sigma Pi Sigma have evolved with the times. This issue of Radiations highlights some of that evolution, with our features focusing on “empowering the next generation,” which can be interpreted in many different ways but gets to the heart of the Sigma Pi Sigma mission. The stories we share within this issue can help us consider the many facets of where we have come from, what it means to contribute to our society, and where we want to go as a community. These topics are mirrored in many of the program elements Sigma Pi Sigma hosts to support students, members, and the community.

Very recently I was reminded of how our past and ideals help to shape our future by one such program: the SPS internship program. I was able to watch 16 of the best and brightest students from across the country discuss science policy legislative processes on Capitol Hill, the history of diversity in the physical sciences, expanding bachelor’s degree career options, cutting-edge research and policy at national labs, and everything in between. It was an amazing window into how the newest members of our community own not just the field’s newest developments but the wide variety of places physicists can make a difference. Our history and traditions are the foundation upon which the future of the field will be built.

Our past traditions and future aspirations will be on full display at the upcoming 2019 Physics Congress. I hope that you have already made plans to join us November 14–16, 2019, in Rhode Island, but if not, on behalf of the SPS/Sigma Pi Sigma Executive Committee, I want to formally extend an invitation. This event is hosted by Sigma Pi Sigma and stems from the first national convention of Sigma Pi Sigma in 1928 at Davidson College. If you are not able to attend in person, please join us on November 16, 2019, as we livestream plenary talks by Dr. Jami Valentine-Miller and Dr. John Mather.
Visitors to the physics commons on the campus of William Jewell College, a private liberal arts college in Liberty, Missouri, often request a look at the departmental scrapbook, filled with collections of pictures and memorabilia dating to the founding of the college in 1849. Along with college history, the scrapbook has the names and pictures of all of the students and faculty who have been inducted into Sigma Pi Sigma.

The founding chapter, consisting of eight student members and two faculty members, was installed on May 20, 1930. The following year, Wallace Hilton—physics faculty member from 1946 to 1983, longtime SPS and Sigma Pi Sigma advisor, and 1979 Oersted Medal winner—was inducted along with two other students from the class of 1933. Since those early days, 409 total members have been added, including the three most recent inductees in April 2019. Nobel Prize winner Walter H. Brattain became an honorary member on April 26, 1979.

Today, one of the most popular pages in the scrapbook features the Sigma Pi Sigma inductees from 1986. Current students and alumni who look closely might recognize a familiar face—current Jewell faculty member Blane Baker, who has been contributing to the department since his days as a student. As an undergraduate at Jewell, Baker majored in physics and was active in both the Society of Physics Students and Sigma Pi Sigma. He began his stint as SPS and Sigma Pi Sigma advisor in 2005, succeeding his mentor, Don Geilker, who had served as an advisor since Hilton’s retirement in 1983. Baker’s six-year tenure on the SPS National Council and his Outstanding Chapter Advisor recognition are indicative of his investment in future generations of physicists.

Baker, along with colleagues Patrick Bunton and Maggie Sherer, have continued the longstanding tradition of engaging students in undergraduate research at Jewell. Over the past three years the department and chapter have also been highly engaged in outreach to public schools. In 2018–19 the chapter received a Society of Physics Students Future Faces of Physics Award to support enrichment and after-school programs by engaging elementary school students in physics activities on waves, light and optics, and solar energy.

The department promotes physics on campus by participating in events such as homecoming and by presenting physics demonstrations and serving donuts on the college Quad—affectionately known as Demos & Donuts. Students and faculty have participated in science camps, physics demonstrations, and sustainability projects in the Texas border region, on Native American reservations in South Dakota, and in the countries of Thailand, Honduras, and Guatemala.

Each week the department hosts the Physics Minute, modeled after a similar activity started at Coe College. Students and faculty gather in the physics commons to listen to a one-minute summary of a topic in science, followed by casual conversations and ice cream. Former Sigma Pi Sigma members also regularly visit the department to reconnect and present on topics ranging from fundamental research to how the study of physics impacts career aspirations.

This Sigma Pi Sigma chapter has a rich history of scholarship, service, and fellowship, and, with a culture of engagement firmly established, should continue inspiring generations to come.
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 www.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

AYSEN TUNCA MEMORIAL SCHOLARSHIP:
Ruth Willet
Kettering University

HERBERT LEVY MEMORIAL SCHOLARSHIP:
Roel Olvera
Texas Lutheran University

AWIS KIRSTEN R. LORENTZEN AWARD SCHOLARSHIP:
Alexandra Detweiler
Illinois Institute of Technology

SCIENCE SYSTEMS AND APPLICATIONS, INC., UNDERREPRESENTED STUDENT SCHOLARSHIP:
Martha Jesuit
Coe College

SCIENCE SYSTEMS AND APPLICATIONS, INC., ACADEMIC SCHOLARSHIP:
Kristiana Smith
Rhodes College

PEGGY DIXON TWO-YEAR SCHOLARSHIP:
Vincent Thompson
Indiana University of Pennsylvania

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 www.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.
We all know a curious kid. They have the world to discover, and they can’t help but ask questions. Today Dr. Daniel Whiteson is a high-energy particle physicist at the University of California, Irvine, but when he was younger, he was one of those kids. “I wanted to access the joy of science,” Whiteson told Radiations, but he could only wonder about the things around him. He didn’t have the tools to actively examine them.

Whiteson hopes that Elinor Wonders Why, a new TV show he and longtime collaborator Jorge Cham have developed for PBS, will give curious children those tools. It all ties into Whiteson’s philosophy for answering children’s questions, which he admits is a little unorthodox. “This is going to sound paradoxical, but try not to answer their question,” he said. “Help them to answer it themselves.”

In the show, Elinor and her friends will do just that. For the most part, they aren’t going to rely on adults to help them figure things out. Instead, they’ll take notes and form testable hypotheses about the phenomena that interest them. They will, in short, do science.

“We’re hoping that kids are encouraged to think curiously,” Whiteson said, “and that their parents and caregivers are more comfortable with that.”

Even though the show is for kids, Whiteson and Cham, a cartoonist and former engineer, also have adults in mind. One goal for Elinor Wonders Why is to clue in parents and other caregivers on how to help kids refine their inquiries. That means “reflecting [kids’] questions back at them” and encouraging them to puzzle out answers for themselves.

“[T]his is an incredible opportunity not just to tell fun stories but to help encourage a generation of kids to be curious and be confident about asking questions,” said Cham. “With all the challenges that we face, it can only help to have citizens that are actively curious and are not afraid to ask questions.”

While conducting research for the show, Whiteson and Cham found that, along with parents, preschool teachers consistently felt...
unprepared to answer kids’ scientific questions. Like most PBS shows, *Elinor Wonders Why* is meant primarily to educate, and Whiteson hopes that Elinor’s adventures will become teaching tools in the classroom.

The duo is particularly excited to bring their brand of science communication to PBS for the network’s reach—specifically, to the children of low-income families. “PBS Kids plays an important role in the way [parents] raise their kids,” Whiteson said. “It’s an honor for us to be part of that process.”

Elinor *Wonders Why* will teach children some science facts, but for Whiteson, it’s more about showing kids how to productively grapple with their queries. “It’s about science, but it’s also about the process,” Whiteson said. He notes that science is often considered a body of facts, when really, it’s just as much about utilizing tools of inquiry to explore the world—the tools he was looking for when he was a young child. “It’s equally important to teach them that science is a way to answer their own questions,” he said.

For more from Whiteson and Cham, check out their book, *We Have No Idea: A Guide to the Unknown Universe*, and their podcast, *Daniel and Jorge Explain the Universe*.

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### About Elinor Wonders Why

by Samantha Staskiewicz, 2019 SPS Summer Intern and SPS Member, The College of New Jersey

Many networks have inspired young people to get involved in science through television shows featuring rocket ships, fun chemical experiments, outdoor adventures, and lots of math and facts. *Elinor Wonders Why* takes a unique approach, sparking scientific interest by starting at the root of science—curiosity. The show aims to inspire young people to ask questions about the world, express their wonders and problems, and use scientific skills to acquire the answers to their questions. Co-creators Daniel Whiteson and Jorge Cham use their backgrounds in physics and knowledge of research processes to shape the structure of the show.

*Elinor Wonders Why* follows a young rabbit, Elinor, through Animal Town, where she’s accompanied by friends Ari the bat and Olive the elephant, as well as several other characters they meet through their adventures. When the crew of animals comes across something they don’t understand, they work together to solve the problem, showcasing a variety of science and engineering principles. Along with the show’s focus on science, *Elinor Wonders Why* delves into important aspects of community, such as diversity, respect, teamwork, and environmental awareness. Children can meet Elinor on the show’s premiere date, Labor Day 2020.
Learning to solve Schrödinger’s equation and calculate the potential of a charged sphere are essential parts of an undergraduate physics education. But for the physics faculty at Chicago State University (CSU), imparting knowledge isn’t the end goal. The Department of Chemistry, Physics, and Engineering Studies has a larger aim—to prepare students to be competitive in a broad range of professional careers, including the health sciences, education, business, engineering, and research. In addition to high-quality teaching and engaging students in active learning, here are three ways the physics program prepares students for success:

1. Involving students in decision-making

At CSU, physics undergraduates have an important voice. They are real collaborators in the development of the physics program, says CSU physics professor Mel Sabella. For example, many undergraduates are peer instructors through the department’s highly successful Learning Assistants (LA) program. LAs facilitate group discussions and classroom engagement in both lower- and upper-division courses. Often, they help develop lessons, choose problems, and provide feedback to faculty about what’s working and what isn’t.

Highly engaged undergraduates are valuable to everyone, according to Sabella. The students gain leadership experience and a sense of ownership in the program. Furthermore, they start to develop a sense of themselves as science professionals capable of making meaningful contributions. “Involving [students] in leadership roles supports their development of science identity. This is especially important for students underrepresented in the STEM disciplines,” explains Sabella.

Meanwhile, the faculty benefits from student insight. Most of the physics undergraduates at CSU come from the South Side of Chicago, so student leaders are intimately familiar with the experiences, cultures, strengths, and challenges of their peers. This enables them to offer perspectives and expertise on the student experience that many faculty members don’t have.

2. Facilitating a diverse, supportive community

After a year at a different university and then a year off from school, Travante Thompson entered CSU juggling three jobs and a baby. “It just felt like home,” he recalls of the department. The active learning focus suited him, but looking back Thompson most appreciates how the faculty members really worked with him as an individual. He came to CSU intending to transfer after two years to a school with an ABET-accredited engineering department but decided to stay after falling in love with physics and experiencing the supportive environment. He graduated with a physics degree in 2018 and is now a beam operator at Fermi National Accelerator Laboratory.
That tight-knit community was the first thing Lionel Pittman noticed when he became a physics faculty member at CSU five years ago. “We know everyone in the department. We learn a lot about their livelihoods and what goes on in their lives,” he says. At times maintaining these personal connections requires a little extra investment, but it’s motivated by a strong desire to see every student succeed, says Pittman.

This strong sense of community isn’t an accident. It is fostered through classroom interactions, informal conversations, and organized department programs such as the LA program, a Society of Physics Students chapter, and a unique Chi Sci Scholars Program that supports cohorts of new chemistry and physics majors. One of the highlights of the scholars program is an off-campus retreat during which students and faculty cook meals together, talk, play games, and get to know each other. The department also together each year on a program to support K–12 students, parents, and teachers in developing science fair project ideas.

“Building a community that trusts each other, that has strong relationships that aren’t just in the classroom… [these] are the really powerful things when you talk about engaging the next generation,” says Sabella.

### 3. Requiring research

All CSU physics majors do research. In fact, to earn a bachelor’s degree in chemistry or physics, students must complete a thesis based on at least 100 hours of directed, original research. The research can be conducted with a faculty member or as part of a summer program or internship, but it must be presented in written form and defended in front of a thesis committee.

A thesis requirement is unusual at the undergraduate level, in part because it requires a lot of faculty effort. However, the department deems it worthwhile because students develop so many important skills along the way. From communication to analysis and problem solving, these skills complement a traditional physics education and prepare students for the modern workforce.

Thompson spent two months at CERN in Switzerland during the summer of 2017 working on high-energy physics research with CSU professors Edmundo Garcia and Austin Harton. He also participated in a different kind of research during his senior year at CSU—a National Science Foundation–funded project to turn one of the CSU classrooms into an engineering lab space. Working with Pittman and Professor Archie Peters, Thompson led a small group of students in proposing a redesign for the space. Through these experiences he learned skills that are not typically taught in the classroom—presenting proposals to stakeholders, collaborative research, staying on budget—but are nevertheless key to successfully navigating a career. This is one of the things that makes CSU different from other departments, says Pittman. “[W]e are not only creating the next generation of physics graduates, but also people who are versed in research skills.”

Some might see these efforts as distractions that dilute the traditional physics education, but the program has a track record of success. CSU plays a national role in increasing diversity in physics, graduating high percentages of African American and female students. Physics bachelor’s degree recipients routinely go on to physics graduate programs, other STEM graduate programs, and STEM jobs. Many alumni stay connected to the department and return to give career talks to undergraduates. According to Thompson, it’s the place to go “if you want to go somewhere where the faculty will work their hardest to make sure that you learn the best way that you learn.”

### Chicago State University At-a-Glance

Type of institution: Public
University enrollment: 2,964 (2018)
Student body: CSU is 69% Black and 68% female. Roughly one-third of the students are first-generation college students, one-third are traditional students, and one-third are nontraditional students.

### Moving On & Looking Back

Felicia Davenport graduated from CSU last spring and is now pursuing a PhD in bioengineering at Georgia Tech. “I thoroughly enjoyed my time at CSU,” she reflects, attributing her positive experience in large part to the close-knit department and the supportive faculty. “I developed mutual feelings of respect and admiration for the faculty members that made me feel supported and safe within the department,” she says. She also credits the focus on “real world” skills for helping physics undergraduates turn into a team of collaborators. “[T]he students are eager to work together to help everyone achieve their own goals,” she says.

The LA Program, Chi Sci Scholars Program, and the Laboratory Modernization Project are partially funded by grants from the National Science Foundation (DUE# 1524829, DUE# 1356523, DUE# 1712389) and the Department of Education.
Better Science Through Diversity
Cal-Bridge draws high-potential students into PhD programs in physics and astronomy

by Korena Di Roma Howley, Contributing Editor

In the winter of 2018, Dennis Calderon had recently returned to school after a three-year absence when he attended a seminar led by Dr. Amy Furniss, an assistant professor of physics at California State University, East Bay. Fascinated by the topic of the talk—an overview of Furniss’s work on very-high-energy gamma rays that come from blazars—Calderon approached Furniss about joining her group. Two years later, he’s set to begin a PhD program at The Ohio State University, where he’ll continue astroparticle physics research while transitioning into the study of neutrinos.

Though Calderon had always been interested in physics, previous college studies had been disrupted by work commitments, a long commute, and financial difficulties. After leaving school, he hadn’t planned to go back. While Furniss’s seminar had rekindled his interest in physics, to see where that interest could take him, Calderon needed the kind of support he had previously lacked—and that’s where Cal-Bridge came in.

“I almost can’t even describe how amazing the program has been,” he says. “I wouldn’t be where I am today without Cal-Bridge.”

Bridging the Gap
Founded in 2014 by Alexander Rudolph, professor of physics and astronomy at Cal Poly Pomona, the Cal-Bridge program supports students along their physics journey while increasing diversity in the field. Modeled in part after the Fisk-Vanderbilt Master’s-to-PhD Bridge Program and funded by the National Science Foundation, Cal-Bridge provides full scholarships, mentorships, and professional development and research opportunities to undergraduate students from groups traditionally underrepresented in physics.

The bridge takes students from the California State University (CSU) system—which offers few doctoral programs—to the PhD programs in physics and astronomy available in the University of California (UC) system, though since the start of Cal-Bridge, students have also been accepted into and attended doctoral programs elsewhere.

Rudolph knew, based on the diversity of the CSU system and its 23 campuses, that the program would have a broad pool of talent to draw from. “I don’t believe that the ability to be a successful physicist or astronomer is related to gender or race or ethnicity in any way,” he says. Both the students and the field as a whole benefit from a more representative community of scientists. “Most science now is done in teams,” Rudolph says. “The image we have in our heads is the lone scientist in his lab—and it’s usually a he … Albert Einstein at his desk, Enrico Fermi in the lab. But in reality, almost everything we do in science nowadays is in teams.”

And, he says, there’s evidence that teams with members who have different perspectives—who come from different parts of society and have different backgrounds—are more productive. “Our field should reflect society, and I think we’ll do better science if we get more people involved and have a more diverse population,” he says.

What Rudolph calls a “holistic selection process” for choosing Cal-Bridge scholars involves looking at a number of characteristics that correlate with success, including academic potential. “We don’t just look at the grades they have, but what we believe they can do,” he says. “We also look for evidence of leadership ability, communication skills, and the ability to have long-term goals.”
And the process takes into account the fact that women and minority students in physics face additional barriers and challenges. “Have they faced a lot of obstacles? is one thing we look at,” Rudolph says, “and the other is, How well do they overcome them?”

The latter, he explains, reveals the grit and persistence it can take to succeed.

When medical issues forced her to withdraw for a semester from her undergraduate studies in astrophysics at San Francisco State University, Imani Ware remained determined to pursue her lifelong dream of becoming an aerospace engineer. She found support through her Cal-Bridge mentors, who helped her communicate with professors, obtain missed study material, and focus on her health and well-being. “They were there for me when I needed them and have given me the opportunity to return to my studies stronger than before,” she says.

For Cristilyn Gardner, now a PhD candidate studying exoplanets at the University of Wyoming, Cal-Bridge removed financial and other pressures, making it possible for her to accept internships and attend workshops, conferences, and a summer research program. “[Cal-Bridge] gave me confidence,” she says. “It put me in the mindset that I could achieve great things.”

The CAMPARE Difference

Two programs fall under the Cal-Bridge umbrella. The first is a partnership between the UC and CSU systems and more than 30 community colleges across the state. Cal-Bridge Scholars that transfer from a community college to a CSU and those recruited directly from CSUs, benefit from mentoring by faculty and research programs at UC and other campuses.

The other program, founded by Rudolph in 2009, is the California Minority Partnership for Astronomy Research and Education, or CAMPARE, which sends students from CSU and California community college campuses to summer research programs in physics, astronomy, astrophysics, and planetary science all over the country.

“Research experience has been shown to help motivate students to go on to get PhDs,” Rudolph says. In fact, of the students who have participated in CAMPARE and earned a bachelor’s degree, 65 percent pursued graduate studies in related fields.

Evan Nuñez is a Cal-Bridge scholar and physics major who recently graduated from Cal Poly Pomona and will be starting an astrophysics PhD program at Caltech this fall. Nuñez attended the University of Wyoming’s research program through CAMPARE, and while there, he says, he was able to live the astronomer’s dream—driving up to a telescope, taking data all night, sleeping through the evening, reducing the data, and then restarting the process all over again. “It turns out that I loved every single part of the experience,” he says, “even the tedious and difficult moments, which was a sign to me that I was going down the right path.”

Paying It Forward

Cal-Bridge participants also make it clear that the program has been, for them, about more than academics. It has fostered a sense of community among and between each year’s cohort of scholars (up to 25 in past years). The existing students help the incoming class, which then does the same for those coming up behind them. And the impulse to pay it forward doesn’t end there.

Driven by their own experiences, Calderon, Gardner, and Nuñez all cited the dual UC and CSU mentorships as a highlight of the program. Each expressed a strong desire to mentor others, not just as time allows but as a focal point of their future careers.

“I want to go into academia—that’s always been a dream of mine,” says Calderon, who’ll be attending Ohio State through its own MS-to-PhD bridge program. But the biggest reason to teach, he says, is to follow in Furniss’s footsteps. “I want to do this for another student,” he says.

According to Nuñez, the mentoring Cal-Bridge provided reminded him that he wasn’t alone. “I always had [someone] I could talk to about how my classes were going, how my research was going, how I was coping with my transition as a transfer student,” he says. And looking toward a career as a research professor or staff scientist, Nuñez says he plans on returning the favor to future students.

Gardner says she feels passionate about the continuation of the program and the role she can play in mentoring others. “I really want to be [in] STEM outreach and mentoring younger kids and even undergraduates,” she says. “If I end up as a faculty member or research scientist… I still want to have some part in that.”

Because the program began in 2014 and participants enter as juniors, none of the Cal-Bridge scholars have yet completed a PhD program. But, says Rudolph, the 80 percent success rate they’ve had for getting into doctoral programs already far surpasses the typical CSU rate, and the quality of the programs is much higher.

“We don’t yet know about the long-term effect,” he says. “But I do have a lot of confidence that we’re going to have a big impact.”

Photos courtesy of the Cal-Bridge program.

TOP: Cal-Bridge scholars tour a physics lab during orientation at the University of California, Santa Cruz.
LEFT: Cal-Bridge North scholars at orientation, September 2018.
RIGHT: Cal-Bridge South scholars at orientation, September 2018.
“I wasn’t really sure what I was in for,” laughs Elon Price as she recalls her first National Society of Black Physicists (NSBP) conference in 2016. At the time, she was just getting into upper-level physics classes as an undergraduate at North Carolina State University. “It was nothing short of an amazing experience to see so many black physicists,” she says. “It was the best thing I could have done so early in my career, because it gave me a sense of community and the encouragement I needed to continue.”

At that NSBP meeting, more than 150 undergraduates, graduate students, and physics faculty gathered at Fermi National Accelerator Laboratory for plenary talks, interactive panel discussions, student research presentations, and networking sessions. The meeting offered a change of scenery for Price, one of three black students in her physics department. She immediately felt welcome and comfortable. She left inspired.

That experience helped Price land a research position and prompted her to become active in the physics community inside and outside of her department. She’s attended two more NSBP conferences since then, as well as larger, topical physics meetings with several thousands of researchers. Topical meetings offer a wealth of opportunities and resources because of their sheer size but can leave some attendees feeling out of place.

“Af[It was so much larger and felt a lot less personal],” says Price about one such meeting. “There was just me and a very small group of people of color. That kind of brought me back to reality a little bit.”

African Americans are significantly underrepresented in physics compared to other fields, and even more so when compared to the general population. The NSBP promotes the professional well-being of African American physicists through efforts aimed at preparing students for success, increasing the number of black physicists, and increasing the visibility of physics contributions by minorities in the field.

Joshua Burrow earned his physics bachelor’s at Morehouse College, a historically black college, in 2012. He attended his first NSBP meeting in 2015 in Baltimore, Maryland. Even though at the time he was attending a historically black college, being surrounded by so many black physicists left an impression. “I felt welcomed by the African American physicists and the allies of our community, and I left inspired to pursue a doctoral degree,” he says. Now a graduate student at the University of Dayton, a predominantly white institution, Burrow says that he appreciates NSBP gatherings even more.

Today, Price is a member of the NSBP student council, and Burrow is the student representative to the NSBP board. As NSBP student leaders,
they are spearheading an effort to establish NSBP chapters on college and university campuses to promote an ongoing sense of community among members. They are also collaborating with the National Society of Hispanic Physicists (NSHP) to plan a student leadership conference for physics undergraduate and graduate students in 2020.

For minority students studying physics, Burrow recommends getting involved in an organization like the NSBP or NSHP. “They provide a sense of hope and belonging and a place where you can build a good network,” he says. To those in the majority, Price suggests spreading the word about these organizations to students who may benefit. She found out about NSBP when a faculty member sent a meeting announcement around by email. “I felt isolated and sort of accepted it,” she says. “When I went to NSBP I definitely felt less isolated, and I didn’t think to do that myself.”

Related Resources
- Conferences for Undergraduate Women in Physics—https://www.aps.org/programs/women/workshops/cuwip.cfm
- National Society of Black Physicists—https://nsbp.org
- National Society of Hispanic Physicists—www.hispanicphysicists.org
- LGBT+ physicists and astronomers—https://lgbtphysicists.org/
- Society for the Advancement of Chicanos and Native Americans in Science—www.sacnas.org

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- Find THE best candidates seeking positions in physics, astronomy, engineering, and other STEM fields!
Physics Instruments
Now & Then
by Kendra Redmond, Editor

New instruments
open doors and trigger creativity.
—Dick Peterson

As physicists push the boundaries of understanding, the citations in their research papers reveal the mountain of knowledge on which new work is built. What may be less considered is the role of instrumentation in the discovery process. Yet digging deeper, looking further, and seeing in greater resolution than ever before requires equipment that’s up to the challenge. In this section, two experts share some of the changes they’ve observed on the job. Their responses to questions from Radiations have been edited slightly for length and clarity.

Dick Peterson: Reflections on the Evolution of Optical Tools

Peterson is a physics professor emeritus at Bethel University, long-time worker in applied optics, and a passionate builder of apparatus for teaching physics. He was a leader in the formation of the Advanced Laboratory Physics Association (ALPhA), past president of the AAPT, and winner of the APS award for research with undergraduates. In 2017 he received the APS Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction.

1. When you consider the field of optics, what strikes you most about how key instruments have evolved over time?

Since I was introduced to the challenges of optical measurements in my student days of the 1960s, I can’t help but first reflect on the impact of gas and solid-state lasers. For example, while doing “pre-laser” optics we championed the coherence length of a low-pressure Hg-198 lamp source for doing interferometry. Physical optics metrology has been totally revolutionized if one compares the mercury lamp coherence length (a few centimeters) to that of the now common stabilized, single-mode He-Ne lasers found in many undergraduate labs (hundreds of meters, or even more). Of course, modern LIGO-level research systems can extend that coherence and stability by additional factors of thousands.

2. Do any other tools stand out as interesting examples of this evolution?

The acousto-optic modulator (AOM). It has always been possible to shift the frequency of light waves as they interact with matter (e.g., Doppler shifts). I recall building a cumbersome moving mirror system to shift light frequencies for heterodyne interferometry around 1970. However, the AOM became a low-cost and easily implemented way to change the frequency, intensity, and phase of light waves. Now optics tables around the world have multiple AOMs for varying applications—including laser cooling systems. I think few of us anticipated how widespread AOM applications would be. Their simplicity and modest cost make them a powerful tool in undergraduate advanced lab projects.

TOP: Antique test meter from an instrument collection at MIT, acquired by the school in the 1940s. The top center instrument is a miniature Weston voltmeter whose scale ranges from 0 to 120. The shape of the voltmeter is reflected in Sigma Pi Sigma’s insignia.

Photo credit: Elmer Cat.

LEFT: This excerpt is from the editorial which appears in the volume 1, issue 1, January 1930 edition of Review of Scientific Instruments. Photo credit: AIP Publishing.
3. How do you view the relationship between research, instruments, and the researcher?
New instruments open doors, trigger creativity, and add to the fun. An experimentalist typically opens a fresh issue of a journal like Review of Scientific Instruments anxious to see if some new tool may broaden the perspectives of their work or (equally important) simply do it better and faster. Decades ago, I had a wonderful postdoc mentor at Los Alamos, Franz Jahoda, who was known for jumping on any new idea or optical gadget from a journal or conference and cleverly employing it the next week in his plasma diagnostics labs. I can still feel his intense (and competitive) experimental focus following such stimulation!

Bert Coursey: Reflections on the Evolution of Nuclear Radiation Equipment

Coursey is a guest researcher in the Standards Coordination Office at the National Institute for Standards and Technology (NIST) and a former editor in chief of the journal Applied Radiation and Isotopes. He is an expert in radioactivity and radiation measurements and has spent 47 years at NIST, nine of them on detail as the director of standards of the Department of Homeland Security.

1. When you consider the history of work in nuclear radiation, what strikes you most about how key instruments have evolved over time?
Modern nuclear instrumentation systems were developed in the mid-20th century for three different applications: diagnostic detection systems for nuclear weapons programs, measurement and control systems for commercial nuclear power stations, and data acquisition systems for high-energy particle accelerators. The central components of these systems are radiation detection instrumentation—ranging from Geiger-Muller counters to solid-state detectors—and analog and digital electronics systems for recording and processing signals from radiation detectors.

TOP: National Bureau of Standards (NBS) staff member sitting at the PILOT computer in 1961. Designed by NBS in 1958, this computer contained three independently programmed systems that could communicate and work together concurrently on a common problem. The PILOT has been called one of the earliest examples of multiprocessor computer architecture. Photo credit: National Institute of Standards and Technology Digital Archives, Gaithersburg, MD.


BOTTOM: Donald Herriott, Ali Javan, and William Bennett with the first helium-neon laser. It produced a steady infrared beam and was the world’s first nonpulsed laser. Photo credit: AIP Emilio Segrè Visual Archives, Hecht Collection.
It clearly made much sense to develop standard detectors, electronics, and data acquisition protocols such that manufacturers could provide nuclear instrumentation components as reliable, off-the-shelf products that met the purposes of these three communities. The IEEE American National Standards Institute (ANSI) Nuclear Instrumentation Committee N42, under the leadership of Louis Costrell at NIST, stepped up to this challenge in the United States. They also provided the leadership in the IEC (International Electrotechnical Commission) Technical Committee TC 45 on nuclear instrumentation.

Radiation detection instruments have benefitted from major advances in physics: first the introduction of inorganic scintillation detectors in the 1960s and then the advent of solid-state detectors (germanium, cesium iodide, etc.) in the 1970s to 1990s. Since 2001 there have been major advances in neutron detectors driven by the needs in homeland security.

2. Are there any tools in the field that you find especially interesting in light of this topic?

Major changes in instrumentation came with the IEEE leadership in standard instrumentation modules. The Nuclear Instrument Module (NIM) bins provide a platform with a power supply that accepts standard components, including preamplifiers, amplifiers, and analog-to-digital converters. USB and other newer interfaces have aided the transition away from custom-built electronics. With advances in computational power, the radiation pulse data acquired is rapidly processed and presented as a gamma-ray radiation spectrum. With an onboard library of gamma-ray spectra, the instrument displays diagnostic information about the source.

3. How do you view the relationship between research, instrumentation and equipment, and the researcher in the field of radiation measurements?

Researchers in these fields use nuclear instrumentation as a tool to interpret radiation interactions with matter. It is not cost effective or productive for them to design the basic instrumentation modules, interfaces, and display systems that they need for their jobs. This gap is filled by fundamental research in radiation physics that leads to new radiation sensors and by the dedicated professional engineers of the IEEE and IEC committees that agree on standard packages and protocols to meet universal needs.

Send us a note with your thoughts on how physics instrumentation has changed over time at sps@aip.org.
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Physics Girl, also known as Dianna Cowern, uses her channel to comment on and explain cool physics concepts. She aims to make science more accessible to everyone, including women and girls. Her super-successful videos earned her a place in the Forbes 30 Under 30 education category and won the top video prize from the Alan Alda Center for Communicating Science at Stony Brook University.

Veritasium, a YouTube channel run by science communicator and filmmaker Derek Muller, shares videos that he says are “simply based on truth”. Focusing on scientific misconceptions, great songs, and fun experiments to test viewers’ scientific logic and reason, Muller’s channel has accumulated over six million subscribers!

Kurzgesagt – In a Nutshell focuses on explaining concepts about the universe through science, with infographics. From the concepts of loneliness and optimistic nihilism, to string theory and what would happen if we brought the Sun to Earth, the channel is ideal for the wandering mind, or for someone who just wants to look at awesome infographics.

MinutePhysics, created by Henry Reich (one of the 2016 PhysCon workshop leaders), explains physical science concepts and theories in terms that everyone can understand in five minutes or less. The clear narration and quirky cartoon drawings of MinutePhysics have acquired quite a large following and led to collaborative videos with other science YouTubers too. Check out the channel to learn about the physics of caramel and the shape of space!
In today’s world, where technology is the main source of information sharing, people snap videos and upload them without thinking all the time; it’s almost second nature to many millennials and Generation Z. From cute videos of kittens to product reviews, YouTube is a wildly popular platform for sharing everything people want to see (and some things people don’t want to see!). It’s also become a great outlet for sharing science with the next generation.

The SPS National Office asked Sigma Pi Sigma members and SPS students to share their favorite science YouTuber channel. Among them, some have millions of subscribers, some are crash courses for general college classes, and others are focused on specific topics like the science behind beauty products or debunking common misconceptions about the world.

Here are a few other YouTubers that members enjoyed viewing as well:

**Vsauce:** Created by Michael Stevens and now split into three different channels, Vsauce aims to answer questions about the universe through thinking, finding, and playing.

**SmarterEveryDay:** This channel is run by Destin Sandlin, who simply wants to get smarter every day and hopes that through his channel, you will too!

**Andrew Dotson:** Dotson’s channel focuses on what it’s like to be a physics student. Topics go from applying to graduate schools to explaining complex theories. Ultimately, Dotson’s channel offers tips and tricks to survive the undergraduate physics major.

**Lab Muffin Beauty Science:** Run by Michelle Wong, this channel aims to debunk myths and explain the science behind beauty products.

Don’t see your favorite YouTuber listed? Let us know who it is and why by emailing SPS@aip.org.
What we know today as Sigma Pi Sigma and the Society of Physics Students began back in 1920 at Davidson College, North Carolina, when four students and five physics department faculty members formed an organization to

...reward high scholarship and promote interest in the advanced study of Physics, to stimulate individual research, to enable its members to keep pace with the progress of the science, and to encourage a spirit of co-operation and friendship among those who have displayed marked ability in this study.¹

In 1920, the field of physics was still being defined, but it was clear to the founders that something was needed to facilitate student cooperation, friendship, and intradepartment collaboration. A formal decision to create such a fraternity was finalized on December 21, 1921, but it was immediately apparent to the founding members that they were different than a “social fraternity of the conventional kind.” The organization immediately became a vehicle for change within the department, gave opportunities for individual student and faculty expression, and let its members “talk shop” informally and freely through seminars and friendly gatherings outside the department. While there was a social component to the fraternity, as was customary at the time, the primary focus was on forming a physics-related professional community through shared meals, scholarship, and development of the department.

Discussion topics ranged from social to science—from physics, to astronomy, to what would become several different physical sciences as we know them today. The group aimed to be “an active factor in the life” of its members.¹

While it may seem that physics departments, and indeed, physics students, must be vastly different today than they were in 1921, an article from the December 1931 issue of The Radiations of Sigma Pi Sigma suggests otherwise.² That issue highlighted the 10th anniversary of the organization and gave an intimate view into the first meetings of the first Sigma Pi Sigma chapter, or the alpha chapter. L. M. Curie, a founding member, tells Radiations readers,

From such a modest beginning, the present organization of Sigma Pi Sigma has grown. From this beginning, however, interest in physics at Davidson has shown a steady increase. The most serious subject for consideration at the first business meeting after organization was a discussion by Price, Brice, and Dew (founding members) as to how much voltage could be applied to “Wooly” Grey (a member of the first group initiated into the chapter in 1922) without doing him any permanent injury. A moderate voltage was decided upon and applied at a later date.

I don’t know if your classmates were anything like mine, but this would fit right in with discussions we had at my chapter at the Rochester Institute of Technology almost 80 years later. In fact, the last time I hosted an induction at Appalachian State University, we made a pun in this vein about giving “the charge” to new Sigma Pi Sigma members. Curie goes on to write,

It seems somewhat the irony of fate that among my first efforts for the good of the cause should have been a paper which I presented to the group sometime during the first year. This paper dealt with dry cells and primary batteries in general. As a punishment for that effort, I have spent the last six years finding out that two-thirds of what I said in my first paper was not true—and I have as yet been unable to find out the reason for the truth of the 33-1/3 percent.

More than any words I could write, this quote gets at the heart of what Sigma Pi Sigma is—not just to individual students and faculty but...
to a department’s sense of identity. Each chapter is a reflection of that department and who they strive to be. The Davidson College members began something that was distinctly its own, something that supported its members and promoted excellence but also could be shared with the broader community of physicists. They saw Sigma Pi Sigma as an agent of change.

It was decided that Sigma Pi Sigma should become a national organization, and on April 12, 1925, a modest expansion program began. A second chapter of Sigma Pi Sigma was chartered at Duke University that spring and a third chapter at the Pennsylvania State University the following academic year. The first national convention of the society was held in 1928, with all six chapters participating. During this period of time, questions of governance, the constitution, and requirements were adjusted to more closely resemble what we know today. Of great debate was the requirements for chapter activity. Ultimately, it was decided that while no formal requirement for regular meetings or activities needed to be specified, chapters should be ingrained within the department culture, faculty and students alike. Early discussions stressed that membership within the society was regarded as an honor to strive for, yet it was well understood that the chapter should benefit the entire department, so much so that it was decided by the 1928 convention to actively promote the concept and vision of Sigma Pi Sigma to colleagues and other institutions. This resulted in rapid expansion, and by June 2, 1930, there were 19 chapters, with 9 of the chapters being installed in 19 days!

Over the following decades, Sigma Pi Sigma continued to grow and respond to the needs of new generations of physical scientists. Through the early support of Marsh White and several other societies, including the American Association for the Advancement of Science, the American Association of Physics Teachers, and the American Institute of Physics, Sigma Pi Sigma has grown to represent hundreds of departments and continues to serve the needs of students, faculty, and the broader community.

The first public symbol of the organization, a pledge badge, was a horseshoe magnet and was adopted on February 22, 1922. Excellence in physics was stressed from the beginning, as members of the first class to be inducted into Sigma Pi Sigma “were expected to prepare some paper on a physics topic.”
I'm really just a polymath at heart. I started my undergrad studies wanting to go into theoretical physics or possibly music theory, but by the end of my junior year, one too many people had asked me why I wasn’t applying to seminary. Now I’m in the ordination process in the United Methodist Church (UMC), studying for my PhD in Hebrew Bible at Emory University and learning about digital scholarship. In my free time (what little exists), I sew much of my wardrobe, write hymns, and do armored combat and scribal work in the Society for Creative Anachronism, among other things.

I’ve never not wanted a PhD, so I’m thrilled to finally be at this stage of my academic career. I absolutely adore learning languages, and studying the Hebrew Bible is a delightful excuse to learn Middle Egyptian, Ugaritic, Akkadian, and Sumerian, in addition to all the modern languages I’m learning on Duolingo now that I’ve passed my German and French exams.

I also TA regularly—especially at the Candler School of Theology—and am a graduate intern at the Emory Center for Digital Scholarship, working primarily on the Sounding Spirit project. The project is creating digital and print editions of five major books of American sacred music from the late 1800s to the early 1900s.

As part of the ordination process, I’m a provisional elder, both to Emory and to the local church I attend, North Decatur UMC. As the theologian-in-residence I’m responsible for various pastoral tasks that include preaching, leading congregational classes (usually on books of the Bible), and writing portions of the updated liturgy for our traditional service. I’ve always been a total church nerd and love high church liturgy (the “smells and bells” type of worship service), so the fact that I get to be part of the team that’s making our service a little more liturgical is wonderful.

I already believed the liberal arts approach to education was a good idea when I was young, but it’s been borne out in my career so far—having some training in pretty diverse fields has been indispensable to just about everything I’ve done up to now, and I only want it to become more so as time goes on.

To aspiring physicists, I say stick with it if you really want to be in the field (that goes for anything, especially in academia), but don’t be afraid to let your interests change if they need to—and take physics with you if they do. Even if you land in the humanities or in the church or somewhere else that people tend to perceive as completely disconnected from science, you’ll find that having that training can help shape the kinds of questions you ask, how you analyze data, and what kinds of patterns you look for.

The same goes for those who follow a STEM path: Get as much training in the humanities as you can, because it will change the kinds of questions you ask and the way you approach both your theoretical work and the practical implications of what you do.
I like to think of myself as a physics drifter, letting this wonderful degree take me from one mission and objective in my career to the next. I’m currently an environmental regulatory compliance engineer, but I doubt my journey will stop here. My career path has never been steady or straightforward, and believe it or not, that aspect has been great.

At an early age, I found myself very excited by machines with speed: jet planes, race cars, space shuttles, you name it. I didn’t know exactly what I wanted to do—I just knew I wanted to go fast, “shake ‘n bake” like Ricky Bobby. In high school I started to realize that some of my ambitions to “just go fast” wouldn’t pan out. When I landed in a great high school physics class, I began to learn the why and how behind going fast, and my love for the science of the physical grew, propelling me into everything science.

Still, I had no interest in pursuing a physics degree in college. No way was I going to be stuck in a lab coat, fiddling around in a makeshift lab, sporting bad hair while searching for plutonium to power my DeLorean. After trying to major in mechanical engineering, electrical engineering, and even English literature, I finally learned that there was life beyond academia and research with a physics degree—options like medicine, law, and architecture.

This sort of quirky educational background landed me in IBM’s Microelectronics Division, where I worked as a semiconductor process engineer. Given my background in physics and materials science, I became one of the outlier thinkers in most of the engineering groups I worked with. I could adapt to almost any role because my somewhat complex educational background came down to something fairly simple—I’m a critical thinker who solves problems. I then successfully transitioned to an industrial engineering role, then an environmental operations engineering role, and now I’m an environmental regulatory compliance engineer with GlobalFoundries.

In this role, I’ve been able to use my physics research skills to implement changes in hazardous and nonhazardous waste operations, ensuring little to no harm comes to our environment through the process of microchip manufacturing. Implementing innovative ideas that help to both satisfy the microchip process and maintain a healthy environment is tough at times, but necessary.

On that same pattern of thought—making innovative creations that are environmentally friendly—I recently started a small business to create and build environmentally safe products for everyday life. This is the newest part of my physics drift, and one that I’m looking forward to making great contributions toward.

If I had known, at the beginning of my collegiate career, all the places a degree in physics could and would take me, I would have never doubted pursuing this degree. I’m still not certain where I’ll end up in my career and have never really had a definitive outlook on the end—but that’s what makes this journey all the more exciting.
“Empowering the Next Generation” forms the theme of this issue of *Radiations*. I was invited to reflect on changes I’ve seen over generations of physicists and offer thoughts on how I think today’s students will impact the field.

On the changes I’ve seen among generations of physicists, I’ll make a personal observation. The first physics conference I attended brought together over a thousand participants. As a young rookie I was a bit intimidated, unsure of the protocols and etiquette of professional physics meetings. I met a few people and managed a few conversations. For facilitating those catalyzing moments, I especially thank a professor from my undergraduate days, Sallie Watkins, who introduced me to her colleagues. Sallie helped me tunnel through some kind of barrier, so I kept going to meetings. At our next meeting, could we be Sallie Watkins to those standing on the fringes?

One can be a first-timer only once, so I cannot say with certainty how social interactions go for first-timers attending large physics conferences today. But I have observation-based reasons to suppose the physics community makes more deliberate efforts nowadays to help first-timers feel part of the club. There are receptions explicitly for first-timers and events that encourage socializing at no extra charge—for a splendid example, the American Physical Society cosponsors the now-expected dance party at Sigma Pi Sigma congresses. When walking around physics meetings today the atmosphere seems more relaxed, with more welcoming openness and diversity than I saw 40 years ago—a work in progress, but encouraging progress.

Regarding future impacts of today’s students, I remember how wise Lady Galadriel in J. R. R. Tolkien’s masterpiece *The Lord of the Rings* eloquently expressed the futility of foretelling: “I do not foretell, for all foretelling is now vain: on the side of darkness is hope.” Nevertheless, Galadriel offered what gifts she could to assist Frodo’s company in their forbidding mission. To Frodo she gave “the light of Eärendil’s star … [that] will shine brighter when night is about you.” Every generation has faced a future of darkness and hope. Perhaps I can pass along a modest Eärendil’s star consisting of what little wisdom I have gleaned (mostly from others), along with key questions that have helped me in my journey.

If I am expected to say something that will empower the newest generation of physicists, I must confess to having words no more profound than any other physicist my age. But I will suggest this to the next generation of physicists: you are empowered already.

You know how to ask questions. You know how to use quantitative, evidence-based reasoning. You know how to be open to new ideas. You are powerful for good. The question is: Will you use your power to address the social, environmental, and economic issues of your time?


while looking them over with a critical eye, saying, “Is that so, eh? How interesting—but what’s the evidence?” Having earned your degree, you are near the place where Freeman Dyson said of his own journey, “I was now ready to start thinking.”

At this point a steep mountain looms before you. A career must be established, a niche found, respect and reputation earned. It is right for us to climb this mountain, to build on the opportunities we were given. Along the way, sometimes we must do what is expedient—there are school loans to repay, rents to make, mouths to feed. But it’s not only what you climb but how you climb that makes all the difference. It’s more about the journey than the destination.

In Zen and the Art of Motorcycle Maintenance, Robert Pirsig describes hiking in the mountains near Bozeman, Montana, with his young son Chris. Chris starts out full of beginner’s enthusiasm, rushing to be the first to top the next rise. But he soon gets tired and frustrated. His walking becomes clumsy and his attitude degenerates to sullen detachment. Pirsig muses, “When you try to climb a mountain to prove how big you are, you almost always never make it. And even if you do it’s a hollow victory. In order to sustain the victory you have to prove yourself again and again … haunted by the fear that the image is not true and someone will find out.” He contrasts such ego-climbing to another climb he attempted years earlier in India, accompanying a group of pilgrims ascending a holy mountain. He dropped out, exhausted, even though many pilgrims who made it were less physically fit than he was. They were driven not by their egos but by their sense of the mountain’s sacredness. The climb was not about themselves.

So instead of asking how we can empower the next generation, I would like to turn the question around and ask the next generation, Who do you wish to empower?

As we ascend our career mountain, we catch glimpses of a valley beyond. It may emerge in the form of the reflective question Why am I doing what I am doing?, as doubts grow about what one’s talents are enabling, as when …

—You help your company develop an impressive new technology intended to make life easier. But you begin to notice that every technology seems to quickly become weaponized—or produces collateral damage, such as eliminating jobs through automation, invading privacy, diminishing manual skills, undermining human agency, or increasing the scandalous gap between rich and poor.

—You begin to realize that your children don’t care how many papers you publish or how many awards you’ve won. What they do care about is whether you were there for them. One cannot attend a conference and a child’s piano recital at the same time—that’s a dilemma. Or you wonder why you knock yourself out on a project that maybe only half a dozen people in the world care about. But then, you never know where even the most esoteric research will lead. That’s another dilemma.

The rude but searching question “Why am I doing what I am doing?” begs a deeper question that must be answered first: What principles guide my decisions? In my times of crossroad decisions, this question has been an Eärendil’s star to me, offering a ray of clarity amid confusing darkness. Answering this question precedes effective responses to the “Why am I doing what I am doing?” and “Who do I wish to empower?” questions.

Physics has no lack of problems, and the world has no lack of needs. But my awareness of a particular problem or need does not necessarily mean it becomes my responsibility to remedy. For me to engage the need with joyful effectiveness, there must be impedance matching between that need and who I am. And while little of significance will ever be done if one always waits for the timing to be perfect, timing is important. Before engaging the task I may first have to take care of family obligations, personal issues, or adequate experience. That’s part of the journey. I must listen to my life. When we know who we are and the time is close enough to being right, when we care deeply for a cause and join with like-minded others in shared commitment, great things happen. Consider a few examples:

—In July 2019, to celebrate the 50th anniversary of the first moon landing, NASA finished restoring the Mission Control room and equipment that guided Apollo 11 in July 1969. In a radio interview, 85-year-old Eugene Kranz, who was the Apollo 11 flight director, recalled, …a group of people united in pursuit of a cause, and basically the result was greater than the sum of the parts… There’s an awful lot of future out there, and what you got to do, is you go out and grab it, wrestle it to the ground… You’ve got the skills. You’ve got the knowledge. You’ve got the love, and you’re capable of moving forward.

—The Cosmic Background Explorer satellite was launched on November 18, 1989, carrying three instruments to measure the cosmic microwave background radiation to unprecedented precision. John Mather, who headed part of COBE’s mission, recalled, The three instruments exceeded all expectations. Few people, including scientists, may realize, however, that by the time COBE scientists began making their series of announcements, many team members had been working full-time on the project for nearly two decades, some devoting their entire working lives to it and staking their careers on its success or failure.

—In his recent book, The Second Mountain, David Brooks tells of Fred Swaniker, who grew up in four African countries. He won a scholarship to Macalester College in Minnesota, and his degree there was followed by corporate work experience and another degree from Stanford. These experiences were Swaniker’s first mountain. But he was haunted by the fact that he had been given these opportunities while hundreds of millions of young Africans just like him never would be.” He envisioned a system of African universities that would educate promising students from across the continent. This was his second mountain. As of 2019, Swaniker’s

6. These metaphors are borrowed from David Brooks, The Second Mountain: The Quest for a Moral Life (Random House, New York, 2019), Ch. 1.
organization has opened the third college of his African Leadership University network. Brooks shares the criteria for commitment—the Éarendil’s star—that guides Swaniker:

> The world is full of problems, but very few are the problems you are meant to address. When you feel the tug of such a moment, Swaniker advises, ask yourself three big questions: First, ‘Is it big enough?’ Those who have been fortunate to receive a good education, who are healthy, and have had great work experiences should not be solving small problems… Second, ‘Am I uniquely positioned to make this happen?’ Look back on the experiences you have had. Have they prepared you for this specific mission? Third, ‘Am I truly passionate?’ Does the issue generate obsessive thinking? Does it keep you up at night?”

Frederick Buechner’s definition of vocation as “the place where your deep gladness meets the world’s deep needs” offers a brilliant polar Éarendil’s star.

Sigma Pi Sigma members are hidden and explicit physicists found in all walks of life, a leaven of evidence-based reasoning and physics appreciation sprinkled throughout society. Accordingly, the Sigma Pi Sigma mission statement includes the components of fellowship and service.

The fellowship component reminds us that we live and work in community. Whatever the cause may be in the spectrum of honorable endeavors—from preserving historic aircraft to detecting gravitational waves to stopping human trafficking—a cause can be effective only when it is empowered by individuals who care and use their talents with like-minded others in purposeful community.

The mission statement’s service component acknowledges that to whom much is given, much is required. Sigma Pi Sigma members have been blessed with talent, opportunities, and tenacity. Resources were made available to us. Teachers, mentors, friends, and family were there for us. They cared about us. What can we give back, and to whom, to uplift and empower some segment of society?

On this journey, there is wisdom in borrowing the wisdom of others. Let us listen to South African novelist Alan Paton: University of Vienna psychiatry professor and Auschwitz survivor Viktor Frankl; and the Dalai Lama:

—in Paton’s moving novel, Cry, The Beloved Country, Arthur Jarvis was a distinguished engineer who became a social conscience in South Africa during the 1940s, as Apartheid was setting up firmly with the 1948 election of the National Party. Nevertheless, Jarvis persisted in his agitation for social justice and the dignity of all human beings. After his tragic murder, his grieving father found Arthur’s personal manifesto, “Private Essay on the Evolution of a South African”:

> I shall no longer ask myself if this or that is expedient, but only if it is right. I shall do this, not because I am noble or unselfish, but because life slips away and because I need for the rest of my journey a star that will not play false with me, a compass that will not lie.”

—in Auschwitz, Frankl observed a pattern among his fellow prisoners: If one could see a meaning for one’s life, then one was more likely to survive. He concluded that “the meaning of life” is not some buried treasure that we are to uncover. Rather, life asks us, What meaning shall we create out of this marvelous gift of our personal existence? Frankl wrote, “It did not really matter what we expected from life, but rather what life expected from us.” Could it be that life asks every new generation of physicists, Now that you have equipped yourself with powerful tools, what will you do with them? This is not a scientific question, but an ethical one.

—in Ethics for the New Millennium the Dalai Lama observes the empowerment that come through knowledge of the material world: Clearly, a major reason for modern society’s devotion to material progress is the very success of science and technology … And we are impressed by the results … Unfortunately, this devotion encourages us to suppose that the keys to happiness are material well-being on the one hand and the power conferred by knowledge on the other … [But] knowledge alone cannot provide the happiness that springs from internal development, that is not reliant on external factors. Indeed, though our very detailed and specific knowledge of external phenomena is an immense achievement, the urge to … narrow down in pursuit of it, far from bringing us happiness, can actually be dangerous. It can cause us to lose touch with the wider reality of human experience and, in particular, our dependence on others.

We as physicists have attained a type of empowerment. If we are to be wise and ethical in its use, what are our responsibilities? Who will we empower, and why? As for the next generation of physicists “impacting the field,” we know our community is far more diverse than, for example, agents of the industrial-military complex. Going forward, the choice of missions and the tone of our profession’s interactions with society can expand such public perceptions to include an appreciation of the physics community as an international treasure, respected for coupling its understanding of the physical world to human empathy. Life asks each of us, What principles guide your decisions? What do you choose as your Éarendil’s star?

11. David Brooks, ref. 6, p. 119.
14. Umar Haque, “The Real Roots of the Crisis,” Harvard Business Review (http://blogs.hbr.org/haque/2010/02/the_real_roots_of_the_crisis.html), February 24, 2010. “What really caused the [2008 financial] crisis was the fact that we didn’t care…. We didn’t care because we were chasing stuff.… In the name of stuff, we sacrificed what mattered: people, community, comity, trust, education, skill, quality, happiness—and tomorrow itself.” Or recall Pirsig (ref. 5, p. 35): “…There is no manual that deals with the real business of motorcycle maintenance, the most important aspect of all. Caring about what you are doing”
Congratulations
to the newest members of Sigma Pi Sigma

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November 16th | 2:45 p.m and 7:45 p.m EST
Livestreaming of two 2019 Physics Congress plenaries:
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