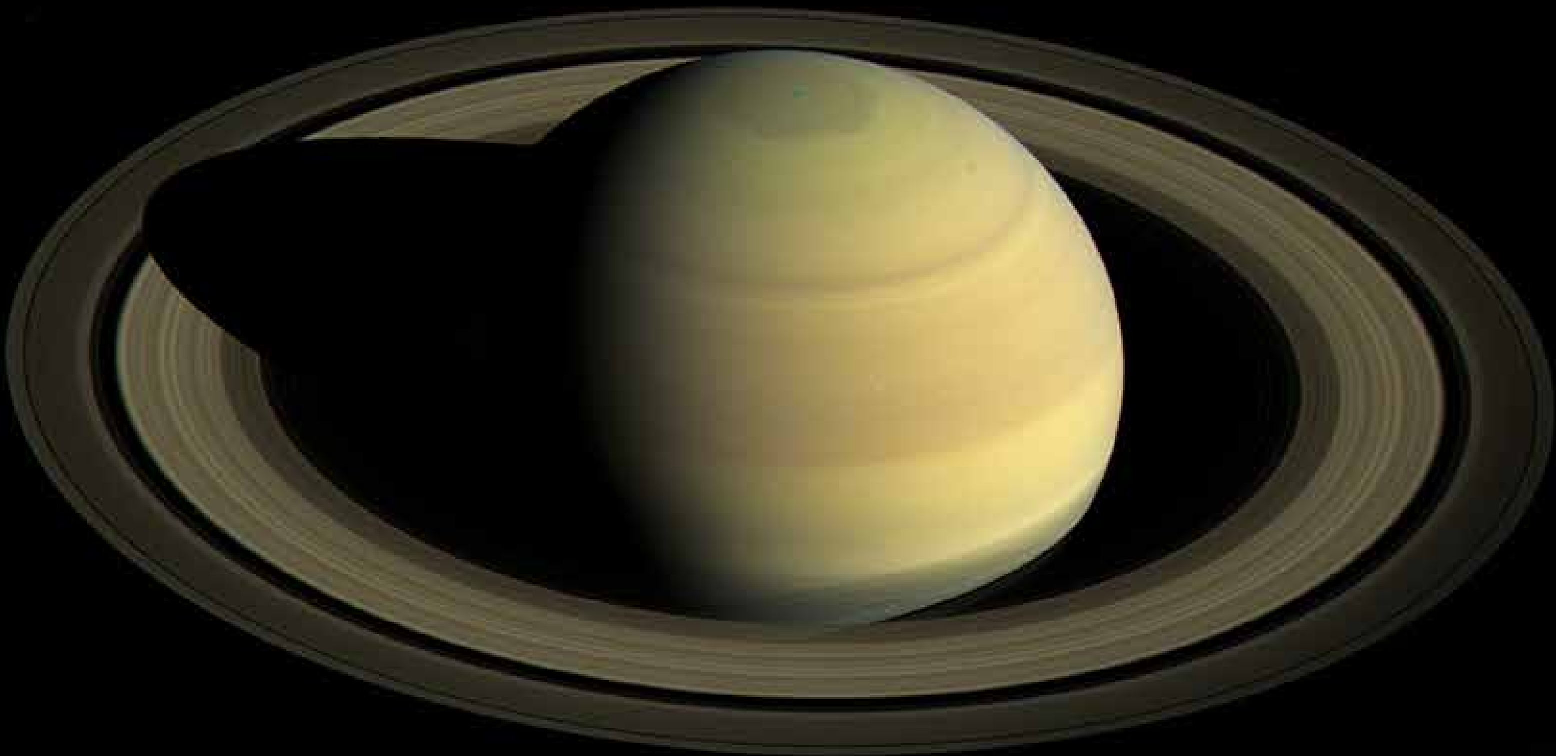
the SPS Observer

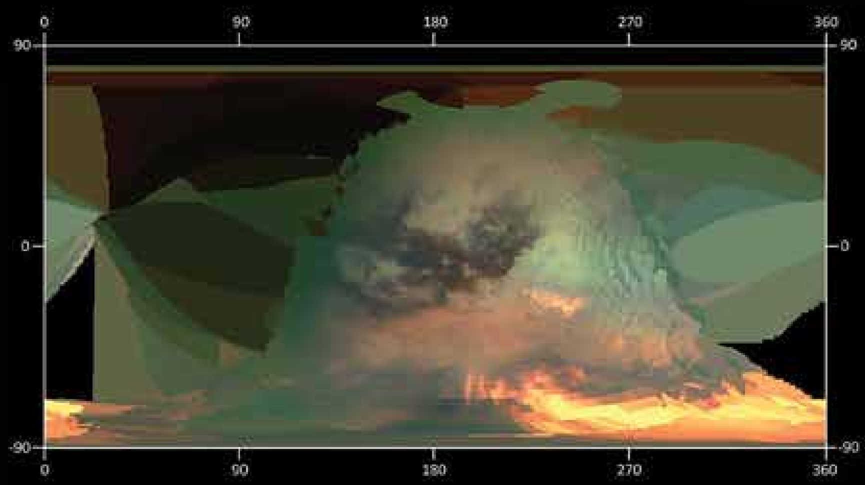
Volume LI, Issue 4

WINTER 2018

Exploring Career Options



- Physics Nobel Prize: LIGO Announcement
- Translating your Academic Career onto a Resume
- Physics in the News



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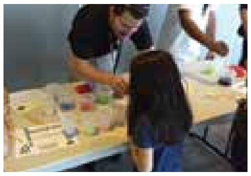

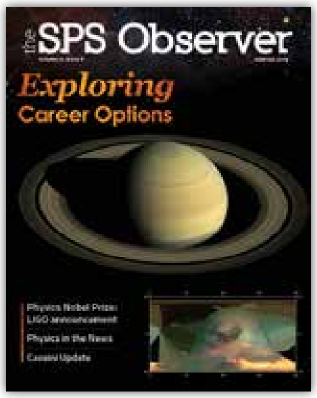

ON THE COVER
NASA's Cassini spacecraft image of gas giant Saturn, displaying the newly observed Hexagonal shaped jet stream. Photo journal: PIA21046 (INSET): False-color image of Titan in the infrared spectrum. See pg. 24 for details.

CORRECTION
In the Winter 2018 issue, within the "Hidden Realities: Lawrence Krauss' Trip to Alaska" article, there are two corrections. First, the author's name was misspelled and should be noted as "Georgeanna Heaverley." Second, the "ABOVE" caption on pg. 33 should read: "Lawrence Krauss presents to a packed audience in Fairbanks, Alaska."

the SPS Observer

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Get Excited: PhysCon 2019

by Dr. Joshua L. Willis, Co-Chair, 2019 PhysCon Executive Planning Committee, Computational Scientist, Caltech/LIGO and Associate Professor of Engineering and Physics, Abilene Christian University

Dear SPS and ΣΠΣ members,

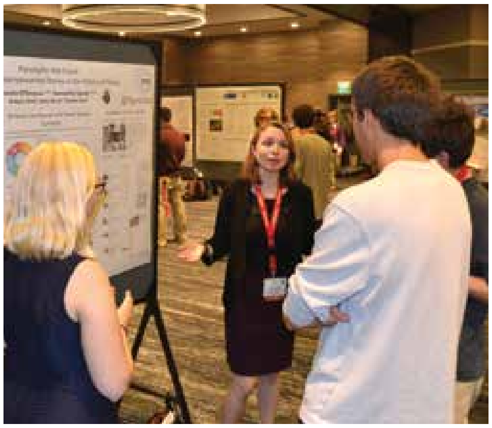
Sigma Pi Sigma's 2019 Physics Congress (PhysCon) is rapidly approaching. In less than two years, students and Sigma Pi Sigma members will gather in Providence, Rhode Island, to share three days of talks, workshops, and camaraderie. Based on the growth of the last several congresses, we are planning for over 1,500 attendees at the largest undergraduate-centered physics conference in the world.

As those of you who have attended can attest, PhysCon is much more than just a conference. Students and faculty from across the US (and a few foreign countries) will gather to hear exciting speakers, from industry to institutes to academia. We will engage in workshops on careers, learn how to build active chapters and departments, and hear from peers about ways to promote diverse chapters that serve their communities. And, PhysCon is in fact a congress where our undergraduates can have a voice in the priorities and plans of both SPS, ΣΠΣ, and their communities.

For attendees, participating in PhysCon will be a high point in their undergraduate study. PhysCon gives a unique perspective on our community and can provide a new focus for the rest of a student's career. But even though the size of this meeting has grown, it is still out of reach for many chapters and individuals who would benefit from attending. As you think about ways that you and your chapter can participate in PhysCon, I also ask you to think about contributing to an endowment in support of future ΣΠΣ Congresses. The funds collected are used exclusively to support a PhysCon endowment so that this life-changing event can happen more regularly and support every student who wants to attend, regardless of circumstance. On behalf of the Organizing Committee and the SPS/ΣΠΣ Executive Committee, please consider if you can donate to establish this conference in perpetuity—the cost of a cup of coffee can make this event a reality for everyone!

Learn more and donate at: donate.aip.org/centennial-campaign

See you in Providence, RI, in November 2019. Watch the *Observer* for more details! //



TOP LEFT: Author Joshua L. Willis.

TOP: Dr. Patrick Brady presents "The Dawn of Gravitational-wave Astronomy" at PhysCon 2016.

MIDDLE: Approximately 1,200 attendees filled the ballroom and meeting halls at the Hyatt Regency-San Francisco Airport.

BOTTOM: Poster presentations gave students a chance to talk shop with mentors and colleagues.

Photos courtesy of American Institute of Physics.

A Guide to Choosing the *Right* Grad Program

by Brad R. Conrad, Director of SPS and Sigma Pi Sigma

Choosing the right graduate school and program can be, to be honest, daunting, but it is also a wonderful opportunity for taking a step along your career pathway. While there are many strategies, the key to determining the right graduate program for you is to understand where you are likely to succeed, your personal preferences for community, and where each program can take you. I stressed the word *you* because your preferences really matter. The overall goal is not to get a degree from a specific institution or even to get a job in a specific field, but to achieve your career and life goals. There are many pathways to your specific goal, and often many programs—sometimes wildly different programs—can help you achieve your goals.

So, before you begin, realize that you are choosing between great opportunities, not good or bad choices. The more honest you are with yourself, the easier it'll be to choose the program that's right for you.

1 FIRST, THE PHYSICAL LOCATION

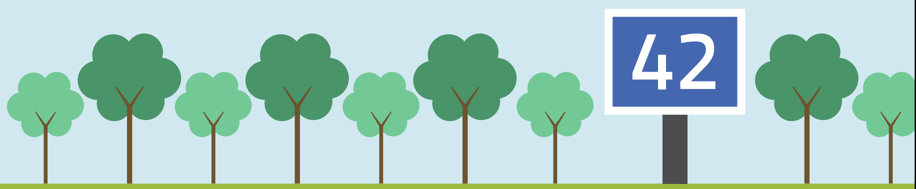
- City vs. Suburban vs. Rural
- Large vs. Small School
- Warmer vs. Colder Climate
- Coastal vs. Midwestern vs. Mountain
- Are there other centers of science nearby?

2 FINANCIALS ARE IMPORTANT: WHAT IS YOUR MOST LIKELY LIVING SITUATION?

- Stipend amount vs. cost of living in that city
  - > Is there a stipend?
  - > Is it a research, teaching, or fellowship position?
  - > Do you need to pay tuition or semester fees?
- Does the program provide health care?
- Does the stipend allow you to live comfortably?

3 LIFE OUTSIDE THE LAB

- House vs. shared apartment vs. campus housing
- Driving vs. biking vs. walking to work
- What is there to do in the area besides school work?
- What do current students do for fun?
- Do students live together? Do they have a social life?
- How many first-year graduate students will be there?
- Are there graduate student organizations you can be a part of?



4 CONSIDER DEPARTMENT CULTURE

- Large, diverse incoming class vs small, personal coursework
- Collaborative or competitive student culture
- Are interdepartmental projects normal?
- Can you work outside the university with national labs and researchers?
- Who teaches the courses?
- Who teaches the labs?
- Do you need to take any labs as a graduate student?
- Is there a foreign language requirement?
- Are there closely related departments: e.g., astrophysics, applied physics, chemical physics, etc.?
- Is there a graduate student group?
- Are graduate students unionized?
- How inclusive and diverse is the department?

5 CONSIDER POTENTIAL ADVISERS

- How many people are there with whom you could be excited to work?
- Do potential advisers have compatible work styles?
- Are there multiple potential advisers you'd be excited to work with?
- Does your potential adviser have research funding?
- Would you need to be a teaching assistant in your later years?
- How is funding within each department?
- What percentage of students who start finish the program?

6 QUESTIONS TO ASK CURRENT STUDENTS

- Are you happy?
- What's it like being a student here?
- Would you come here again if you could do it over again?
- What's the worst part of being a student here?
- What's the best part of being a student here?
- What did they not tell you about in orientation?
- Is the stipend enough?
- Are students involved in community events?
- Do you like the department? Is it cohesive and supportive?

This list of questions is far from exhaustive. It's meant to get you to think about the things that are important to you in graduate school.

While courses and the broader department matter most for your first two years, your adviser and research group matter most for the remaining years in graduate school. So, don't skip out on researching both aspects: classes and department culture versus individual advisers and research groups. Look at lots of schools that meet your criteria on GradSchoolShopper.com.

One item which is often overlooked is that your social and emotional well-being is just as important as your academic life. If you choose the perfect school for your career but you aren't happy there, it can be very difficult to succeed. Correspondingly, if you are at a school that matches your style but you aren't happy with your academic options, this can be an issue as well. Many students do not consider life issues and personal preferences when choosing their graduate programs, and this can alter their chances of success.

Above all else, realize that there is most likely not just one school that is the perfect school but many schools that can work for you. So do your grad school research well and ask the hard questions. If you do, you'll likely end up in the place best for you. Good luck! //

Outstanding SPS Chapter Awards

OUTSTANDING CHAPTERS

Abilene Christian University (TX) (Zone 13)
Adelphi University (NY) (Zone 2)
Angelo State University (TX) (Zone 13)
Augustana College (IL) (Zone 9)
Austin Peay State University (TN) (Zone 8)
Berry College (GA) (Zone 6)
California State University, Chico (CA) (Zone 18)
California State University, Fresno (CA) (Zone 18)
California State University, Sacramento (CA) (Zone 18)
Carthage College (WI) (Zone 9)
Central Washington University (WA) (Zone 17)
Cleveland State University (OH) (Zone 7)
Coe College (IA) (Zone 11)
Colorado School of Mines (CO) (Zone 14)
Drexel University (PA) (Zone 3)
Emory University (GA) (Zone 6)
Florida International University (FL) (Zone 6)
Florida Polytechnic University (FL) (Zone 6)
George Washington University (DC) (Zone 4)
Georgia Institute of Technology (GA) (Zone 6)
Guilford College (NC) (Zone 5)
Henderson State University (AR) (Zone 10)
High Point University (NC) (Zone 5)
Ithaca College (NY) (Zone 2)
Kettering University, Section B (MI) (Zone 7)
Lamar University (TX) (Zone 13)
Loyola University New Orleans (LA) (Zone 10)
Lycoming College (PA) (Zone 3)
Manchester University (IN) (Zone 9)
Metropolitan State University of Denver (CO) (Zone 14)
Miami University (OH) (Zone 7)
North Carolina State University (NC) (Zone 5)
Northern Virginia Community College (VA) (Zone 4)
Oregon State University (OR) (Zone 17)
Randolph College (VA) (Zone 3)
Rensselaer Polytechnic Institute (NY) (Zone 2)
Rhodes College (TN) (Zone 10)
Sonoma State University (CA) (Zone 18)
St. Mary's University (TX) (Zone 13)
Stephen F. Austin State University (TX) (Zone 13)
Tarleton State University (TX) (Zone 13)

DISTINGUISHED CHAPTERS

Arizona State University (AZ) (Zone 16)
Augsburg College (MN) (Zone 11)
Augusta University (GA) (Zone 6)
Baylor University (TX) (Zone 13)
Benedictine University (IL) (Zone 9)
Bethel University (MN) (Zone 11)
Bridgewater State College (MA) (Zone 1)
Butler University (IN) (Zone 8)
California State University San Marcos (CA) (Zone 18)
California State University Stanislaus (CA) (Zone 18)
Christian Brothers University (TN) (Zone 10)
College of Charleston (SC) (Zone 5)
College of William and Mary (VA) (Zone 4)
Colorado Mesa University (CO) (Zone 14)
Creighton University (NE) (Zone 11)
Davidson College (NC) (Zone 5)
Denison University (OH) (Zone 7)
DePaul University (IN) (Zone 8)
Dillard University (LA) (Zone 10)
Eastern Michigan University (MI) (Zone 7)
Embry-Riddle Aeronautical University, Daytona Beach (FL) (Zone 6)
Florida State University (FL) (Zone 6)
Georgia Southern University (GA) (Zone 6)
Gordon College (MA) (Zone 1)
Gustavus Adolphus College (MN) (Zone 11)
Hendrix College (AR) (Zone 10)
Howard University (DC) (Zone 4)
Idaho State University (ID) (Zone 15)
Juniata College (PA) (Zone 3)
Kettering University, Section A (MI) (Zone 7)
Lee College (TX) (Zone 13)
Louisiana State University (LA) (Zone 10)
Louisiana Tech University (LA) (Zone 10)
Manhattan College (NY) (Zone 2)
Messiah College (PA) (Zone 3)
Millikin University (IL) (Zone 8)
Minnesota State University Moorhead (MN) (Zone 11)
Moravian College (PA) (Zone 3)
Morehouse College (GA) (Zone 6)
Mount Holyoke College (MA) (Zone 1)
New Mexico State University (NM) (Zone 16)
Oglethorpe University (GA) (Zone 6)
Randolph - Macon College (VA) (Zone 4)
Roanoke College (VA) (Zone 4)
Rockhurst University (MO) (Zone 15)

NOTABLE CHAPTERS

Agnes Scott College (GA) (Zone 6)
Appalachian State University (NC) (Zone 5)
Ball State University (IN) (Zone 9)
Bridgewater College (VA) (Zone 4)
Buffalo State College (NY) (Zone 2)
Clemson University (SC) (Zone 5)
East Central University (OK) (Zone 12)
Elon University (NC) (Zone 5)
Florida Institute of Technology (FL) (Zone 6)
Furman University (SC) (Zone 5)
Georgian Court University (NJ) (Zone 3)
Grambling State University (LA) (Zone 10)
Grand Valley State University (MI) (Zone 7)
Green River College (WA) (Zone 17)
Grove City College (PA) (Zone 7)
Harvard University (MA) (Zone 1)
Haverford College (PA) (Zone 3)
Houston Baptist University (TX) (Zone 13)
Illinois Institute of Technology (IL) (Zone 9)
Jacksonville University (FL) (Zone 6)
John Carroll University (OH) (Zone 7)
Kenyon College (OH) (Zone 7)
Knox College (IL) (Zone 9)
Lawrence Technological University (MI) (Zone 7)
Longwood University (VA) (Zone 4)
Marquette University (WI) (Zone 9)
MIT (MA) (Zone 1)
Murray State University (KY) (Zone 8)
North Dakota State University (ND) (Zone 11)
NYU (NY) (Zone 2)
Ohio University (OH) (Zone 7)
Ohio Wesleyan University (OH) (Zone 7)
Old Dominion University (VA) (Zone 4)

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

Texas Lutheran University (TX) (Zone 13)
The College of Wooster (OH) (Zone 7)
Towson University (MD) (Zone 4)
University of Alaska Fairbanks (AK) (Zone 17)
University of California Merced (CA) (Zone 18)
University of Central Arkansas (AR) (Zone 10)
University of Colorado Denver (CO) (Zone 14)
University of Illinois at Urbana-Champaign (IL) (Zone 8)
University of Louisville (KY) (Zone 8)
University of Maine (ME) (Zone 1)
University of Maryland, College Park (MD) (Zone 4)
University of Michigan - Ann Arbor (MI) (Zone 7)
University of Minnesota - Twin Cities (MN) (Zone 11)
University of Mississippi (MS) (Zone 10)
University of North Carolina at Asheville (NC) (Zone 5)
University of Oregon (OR) (Zone 17)
University of San Diego (CA) (Zone 18)
University of Southern Mississippi (MS) (Zone 10)
University of Tennessee, Knoxville (TN) (Zone 8)
University of the Sciences (PA) (Zone 3)
University of Utah (UT) (Zone 15)
University of Virginia (VA) (Zone 4)
University of Washington - Bothell (WA) (Zone 17)
University of Washington (WA) (Zone 17)
University of Wisconsin - La Crosse (WI) (Zone 9)
University of Wisconsin - River Falls (WI) (Zone 9)
US Air Force Academy (CO) (Zone 14)
Utah State University (UT) (Zone 15)
Wayne State University (MI) (Zone 7)
Wheaton College (IL) (Zone 9)
William Jewell College (MO) (Zone 12)

Rutgers University (NJ) (Zone 3)
Seton Hall University (NJ) (Zone 3)
Sewanee: The University of the South (TN) (Zone 10)
Southwestern Oklahoma State University (OK) (Zone 12)
St. John's University (NY) (Zone 2)
Swarthmore College (PA) (Zone 3)
Syracuse University (NY) (Zone 2)
Texas A&M University - Commerce (TX) (Zone 13)
Texas Tech University (TX) (Zone 13)
The Ohio State University (OH) (Zone 7)
The Pennsylvania State University (PA) (Zone 3)
The University of Memphis (TN) (Zone 10)
The University of Texas at Dallas (TX) (Zone 13)
The University of West Florida (FL) (Zone 6)
Truman State University (MO) (Zone 12)
Union College (NY) (Zone 2)
Union University (TN) (Zone 10)
University of California, Berkeley (CA) (Zone 18)
University of Dayton (OH) (Zone 7)
University of Denver (CO) (Zone 14)
University of Evansville (IN) (Zone 8)
University of Houston (TX) (Zone 13)
University of Pittsburgh (PA) (Zone 7)
University of Puerto Rico, Rio Piedras Campus (PR) (Zone 6)
University of South Alabama (AL) (Zone 6)
University of South Carolina, Columbia (SC) (Zone 5)
University of Texas at El Paso (TX) (Zone 13)
University of Texas at San Antonio (TX) (Zone 13)
University of Texas Rio Grande Valley (TX) (Zone 13)
University of Wisconsin - Eau Claire (WI) (Zone 9)
University of Wyoming (WY) (Zone 14)
Virginia Tech (VA) (Zone 4)
Washington University in St. Louis (MO) (Zone 12)

Peninsula College (WA) (Zone 17)
Pittsburg State University (KS) (Zone 12)
Portland State University (OR) (Zone 17)
Princeton University (NJ) (Zone 3)
Radford University (VA) (Zone 4)
Roberts Wesleyan University (NY) (Zone 2)
Rollins College (FL) (Zone 6)
Saint Michael's College (VT) (Zone 1)
Salisbury University (MD) (Zone 4)
Sam Houston State University (TX) (Zone 13)
Smith College (MA) (Zone 1)
South Dakota State University (SD) (Zone 11)
Stevens Institute of Technology (NJ) (Zone 3)
Sun Yat-sen University (China) (Zone 18)
SUNY College at Potsdam (NY) (Zone 2)
Texas State University (TX) (Zone 13)
The City College of New York (NY) (Zone 2)
The College of New Jersey (NJ) (Zone 3)
University of Central Missouri (MO) (Zone 12)
University of Missouri - Columbia (MO) (Zone 12)
University of Nevada, Reno (NV) (Zone 18)
University of North Alabama (AL) (Zone 6)
Utah Valley University (UT) (Zone 15)
Virginia Military Institute (VA) (Zone 4)
Wake Forest University (NC) (Zone 5)
Washington State University (WA) (Zone 17)
Whitman College (WA) (Zone 17)
Wittenberg University (OH) (Zone 7)

Melon Physics:
Williams College Summer Outreach

by Ellery Galvin, SPS Member, Williams College, with contributions from the Williams College SPS Chapter

This summer, the Williams College SPS chapter designed an afternoon of "Watermelon Adventuretime Excursions." About a dozen Williams College student researchers in physics, computer science, and math traveled to Windsor Lake to compete in a series of artistic, athletic, engineering, and eating challenges. Onlookers gazed at heaping armfuls of melons. Each team created a melon mascot by combining a melon with three random objects, and improvised a skit with a theme, a cheer, and a name.

One athletic challenge had competitors race with their melons in the water along the length of the beach. Thankfully, though the water in the melons makes them heavy, the rinds are lighter than an equivalent volume of water, so they float! The lifeguards were intrigued and amused by the competition.

Back at Williams, teams had 60 minutes to engineer the longest bridge able to bear a rolling melon. They used only cardboard, twine, croquet mallets, duct tape, and trash bags. Judges awarded extra points if the bridge remained standing after being impacted by a falling melon. As evidenced by the post-test mess, a melon dropped on a flat surface breaks easily since the force of impact is imparted on a small area.

When all the sticky flesh of the unlucky melons was cleaned from the lawn, everyone gathered around a plate of luckier melons for yums and laughs. The event cultivated friendships between related academic departments and exploited the unique physical features of watermelons. It also encouraged the people at Windsor Lake to think about physics and to meet our welcoming students. In future versions of this event, we will invite younger students to teach them the physics of melons and connect them with undergraduates who love sharing the fun of physics.

During the year, our chapter has focused on making the department more approachable. On Thursday nights, we enjoy snacks prepared by students as a way of resting busy minds. Students from all class years, alumni, and professors often attend weekly lunches. Some days we share our experiences, describe changes we want to see in the curriculum, or advise one another; on other days, we imagine Velcro theme parks or estimate the number of leaves on a nearby mountain. Our hope is that everyone, from the seniors linearizing Einstein's equation for the study of gravitational waves to the spectators of lakeside watermelon antics, will feel like a friend of physics. //

TOP: Students Emily Stump, Ian Shen, and Iona Binnie pose with "Melanie the Melodic Melon." The cheer reads, "The melons, the melons, we greet them with a song!" and is a parody of Williams' alma mater song. Photo by Ellery Galvin.

ABOVE: Judge Kirby Gordon drops an unlucky melon onto a bridge. Photo by Iona Binnie.

DON'T PANIC:

IT DOESN'T ALL HAVE TO BE FIGURED OUT *NOW*

by Brad R. Conrad, Director of SPS and Sigma Pi Sigma

Every good article starts with personal confessions:

- I don't know what I want to be when I grow up.
- I still haven't decided on a career.
- I applied to positions simply because they looked cool/exciting.
- For me, it's intimidating that careers are journeys, not destinations.

For the longest time, it seemed like careers were things that people planned out to a T, knowing exactly which jobs and positions they wanted. It wasn't until well after undergrad that I realized not only was it OK to **not** have the next 30 years of my life figured out (and that most people don't), but it was also OK to allow for opportunities to come along. But, just because something is OK, that doesn't mean it's necessarily stress free. It's hard to apply for graduate programs, jobs, and internships but deciding which ones to apply for, in my opinion, is even harder. The act of choosing among so many good options is a real challenge for many.

At one point in my life, I was determined to be an astrophysicist working at NASA, and I was more than willing to move to Mars at the first available opportunity. Seriously. While this is still something I would enjoy doing, I was open to opportunities that came along. For example, in graduate school I wanted to work at NASA, but my timing was off for all the missions I found exciting (too early or almost completed). Instead of working at NASA, I tried out several groups that had exciting physics and ended up working in a lab that did surface science (and I don't mean planet or asteroid surfaces). While totally different, that choice led me to wonderful physics problems, life-changing colleagues, and positions I would have never thought possible (such as director of SPS)! Being open to options changed my life.

Even though it worked out well, I will always remember feeling completely lost when looking for a research group in graduate school. Did I make a huge mistake in going? I thought about quitting and almost changed schools because I felt so uneasy. Plus, I had no financial safety net, so I had to make something work or I might be without a place to sleep. But, because I was open to opportunities and did my due diligence by exploring what was available to me, I ended up exactly where I'd choose to be if I could do it all over again. Options are scary. The unknown is scary. The act of choosing schools and careers have lifelong implications, but there was no way I could plan it all out. And that's OK!

The features of this quarter's issue focus on several facets of career pathways. Check out the career options map to consider all of your options: everything from the private sector to teaching to graduate school. We highlight not only the differences between theoretical, computational, and applied physicists, but also show you some of the wide phase space available to you: science communication, education, nonprofits, and even data science. And careers are not about titles but about accomplishments, so we explore some of the exciting physics and astronomy that has happened in the past few weeks. While careers can be random walks at times, a little planning can go a long way in helping you achieve your goals.

The takeaway: Don't panic. You don't have to have it all figured out today. //

FEATURE

EXPLORING OPTIONS, FINDING OPPORTUNITIES

by Rachel Kaufman, Editor and Kendra Remond, Contributing Writer

Adapted from the Careers Toolbox, recently updated in 2018, available at spsnational.org/careerstoolbox.

First, the good news—a degree in physics leads to a wide variety of career options. The challenge is that successfully navigating all of the available opportunities can be overwhelming, especially when most students are only exposed to the physicists at their school—those who have earned a PhD and are now working in academia.

Because there are so many possible pathways available, deciding on a good fit for their unique set of knowledge, skills, and (most importantly) interests is difficult for many students. SPS has a number of resources designed to help students navigate this challenge, from the AIP Careers Toolbox, designed specifically for students interested in entering the workforce after earning a bachelor's degree, to profiles of physicists (like those featured here) and data on the common paths of physics majors.

Check out the projects on the following pages to see which ones might help you in your own career journey, and be sure to browse the profiles of the not-so-traditional physicists featured here—they might just open your eyes to opportunities you never knew existed.

THE AIP CAREERS TOOLBOX

You can find physics majors in ALL kinds of professions—science writing, medicine, law, history of science, acting, music, healthcare, and more. The Careers Toolbox will give you a deeper awareness of the wide range of career options for physicists, and it will help you figure out how to get the job you want. It's packed with resources for finding career help on campus, overcoming obstacles you might run into, and for empowering you to make your physics department more "career friendly." It also includes hands-on activities to help you narrow down your career options and then nail the job you want.

Learn more at: www.spsnational.org/career-resources/career-pathways

CAREER ADVICE FOR STUDENTS

Need specific advice? SPS has deep dives into various career-related topics in webinar form available online. In the webinars, you can learn about networking and interviewing, for example. There's also a webinar perfect for most physics undergrads, with the title "I'm about to graduate—What on earth do I do now?" (If that doesn't resonate, consider yourself lucky!)

Prefer to read rather than watch? SPS also has dozens of articles on job-search topics. Learn about networking, informational interviews, and using LinkedIn effectively. There are also tips on broader topics, like figuring out your goals and values in life.

Get these resources at: www.spsnational.org/career-resources/webinars and www.spsnational.org/career-resources/advice

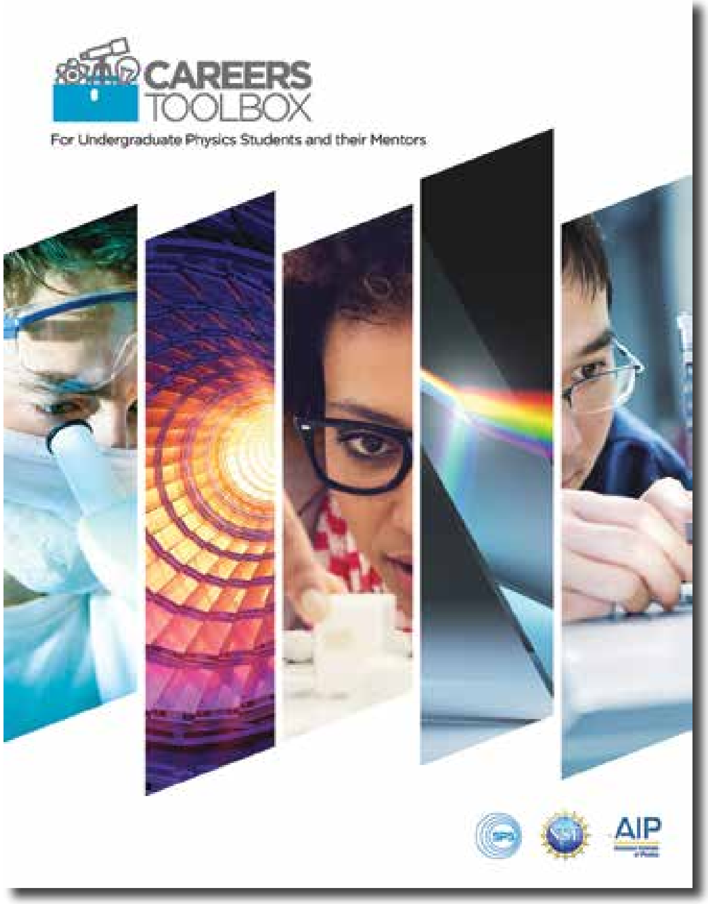
LEARNING FROM THOSE WHO CAME BEFORE

Sometimes you just want to hear how other people handled a situation similar to one you find yourself in. A great way to do this is to find a mentor you can talk with in person. But if that's not possible—or if your mentor hasn't been through the situation you're struggling with—you can learn from "virtual" mentors. *The SPS Observer* publishes advice from experienced voices on almost every possible topic imaginable: internships, outreach, job fairs, even learning from failure.

Read that advice at: www.spsnational.org/the-sps-observer/sps-observer-departments/pathways-advice-experienced-voices

Finally, if the physicist profiles that follow pique your interest, read about the many other careers for physicists by visiting SPS's physicist profiles page at www.spsnational.org/career-resources/physicist-profiles and Sigma Pi Sigma's list of "Hidden Physicists" at www.sigmapisigma.org/sigmapisigma/radiations/hidden-physicists.

Best of luck on your career journey!



ABOVE: The Careers Toolbox was recently updated in 2018.

JAKE ZALKIND, BS Ed, Physics, Shippensburg University of Pennsylvania, Physics Teacher at Bohemia Manor High School

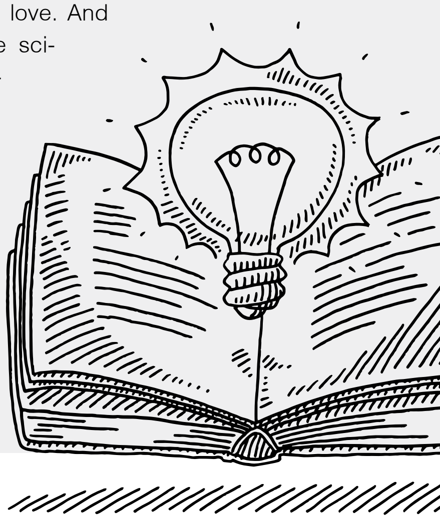
I always knew I wanted to help people by teaching. I started as a history education major, but I switched to physics because, well, physics is easier!

My favorite lesson is a lab on projectile motion called Shoot for Your Grade. The students have to calculate where their projectile will land, and they get a better grade the closer they hit.

Motivation: I teach for that "eureka moment." I get to show kids cool stuff. A lot of kids think physics is just a hard, scary subject with a lot of math, but they don't think about the cool stuff that you can do with it.

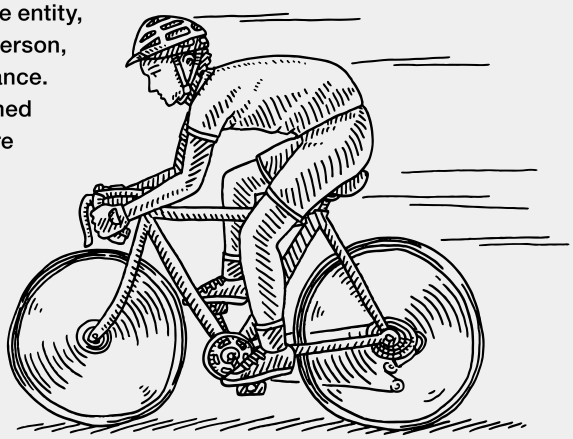
Advice for students: Do what you love. And we always need educators in the sciences—there's never an overpopulation of science teachers, so if you're a physicist and want to be an educator, you'll have no problem finding a job.

Physicists tend to make great teachers because we think logically, we're tough, we're smart, and we can handle any challenge.



PETER MUHORO, BSc Physics and Math, Hampton University; MSc Applied Physics, University of Michigan; PhD Applied Physics, University of Michigan, Vice President of Strategic Industry Research and Analysis at the National Rural Utilities Cooperative Finance Corporation

If you asked me if I ever thought I'd work at a finance entity, my answer would have been no. I'm not a finance person, but I continue to learn as much as I can about finance. I help electric co-ops—not-for-profit, member-owned electric utility companies—figure out what the future looks like. When somebody comes to me and says, "I want to install a battery bank, can you loan me $1 million?" it's my job to understand the technical and business factors that make that a good or bad loan.



Key skills: Communicating and public speaking. I went back and read my dissertation, and I was like, "I'm a horrible writer!" Years later I've improved my writing skills. Practice makes perfect.

Daily challenges: I've run into a lot of "Well, we've always done it this way," or "We tried this, and it didn't work." That's challenging, because I want to be like, "Let's jump in and try it."

Motivation: Creating change—I want to look back some day and say my input was one of the reasons this project was successful. That gets me moving.

Advice to students: Find several mentors. The classroom is great, but it's being around someone and seeing how they do things that can be exactly what you need to learn.

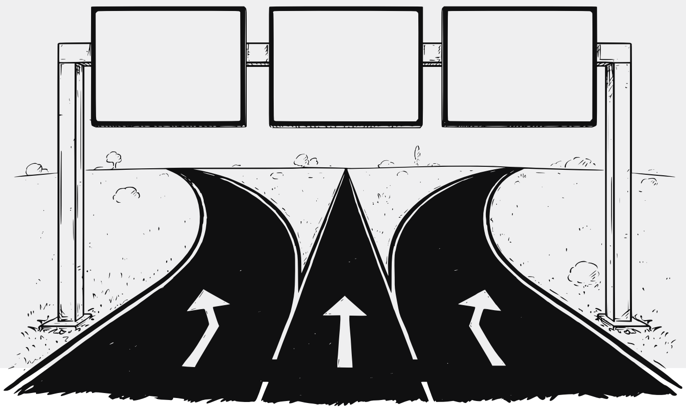
"MANY THINGS ARE CAUGHT, not taught."

- Peter Muhoro

SEAN GRULLON, BS Physics, Florida International University; PhD Physics, University of Wisconsin–Madison, Machine Learning Data Scientist, GSK

As I was getting to the end of my postdoc, I recognized that I really enjoyed doing physics research, but I didn't want to be a professor. I had worked on a lot of statistics, data analysis, and machine learning in my research career. At the time, the data science field was taking off, and that's when I decided to take what I learned in research and apply that to industry. And I've been pleasantly surprised by the number of very interesting technical challenges and problems that need to be solved in industry.

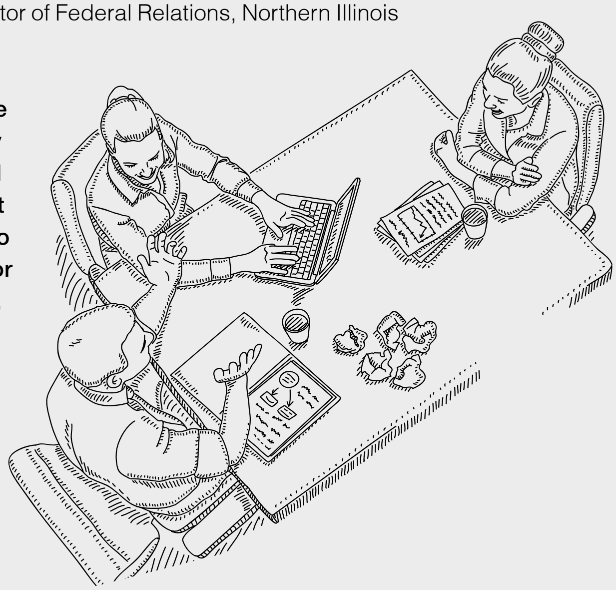
Why physicists matter: Physicists are well suited to be data scientists. They've looked at and analyzed real data. My personal experience is, computer science is great, but a lot of CS and math students haven't dealt with the complexities and messiness of real data.



Key skills: Fundamental math and statistics. Machine learning is a hot topic these days, but when you break down the algorithms, it's just linear algebra with a little bit of chain rule, and also technical skills, like Python, which I used a lot in my academic career, too. Getting involved in research projects early on would help expose you to that language.

Motivation: The most exciting thing is how quickly this field is changing. The software I used two years ago? Nobody uses it anymore. The approach I used two years ago? Nobody uses it anymore. It's exhilarating.

ANNA QUIDER, BA Religious Studies and BS Physics and Astronomy, University of Pittsburgh; PhD Astronomy, University of Cambridge, Director of Federal Relations, Northern Illinois University



I spend time making sure that the people in power know what's important to my university. I work on everything at the federal level that touches our university, so student financial aid, immigration, etc. - but also things that affect our faculty, like funding for the National Science Foundation or the National Endowment for the Arts, or policies that affect research. And I also work on things that affect the university as an employer, like tax policy. So there's a whole range of things I have to learn all the time! It's one of the best things about my job.

Key skills: As a physicist, I learned how to approach complicated problems, and I'm not intimidated by them. Physicists work on problems that may literally have no known solution. It's similar to when you're trying to figure out how to solve a policy problem.

Physics also gave me a strong numerical sense. I ask questions about the data: What's the sample size? What was the selection bias in this survey? How was this data analysis completed? And so on.

Advice to students: If you are interested in policy, get policy experience! Take political science courses while you're doing your physics coursework. Or volunteer on a campaign—you could do an hour a week and still have a worthwhile experience. It's going to result in dynamic reference letters, getting a sense of the broader world out there, and frankly, I think it makes us all better citizens when we have an involvement in the civic process.

Most universities, even small ones, have somebody like me on staff. Find that person and email them, see if you can learn about their job. They might have an internship opening!

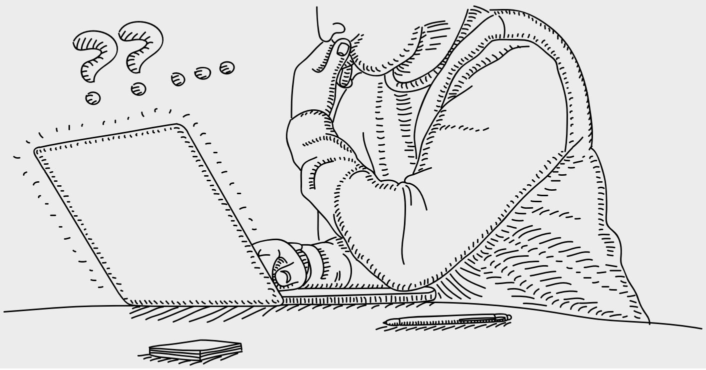
ADELE LUTA, BS Physics, Florida Institute of Technology; MS Physics Entrepreneurship, Case Western Reserve University, Research Affiliate with MIT's Department of Brain and Cognitive Sciences

As a physicist, I was inspired to understand more about the human mind after working as a National Aeronautics and Space Administration (NASA) Mission Control Center flight controller and astronaut instructor. Now I work as a research affiliate with MIT, studying how people react in time-limited, life-critical, restricted communication environments—think astronauts or special ops forces. As an applied scientist, I have the opportunity to work with individuals performing these critical jobs, which is one of my favorite aspects.

Key skills: It's important to have a solid understanding of the science and be up to date on the latest research. It's also key to build a network within the scientific community. Finally, be confident in your ideas and stay persistent.

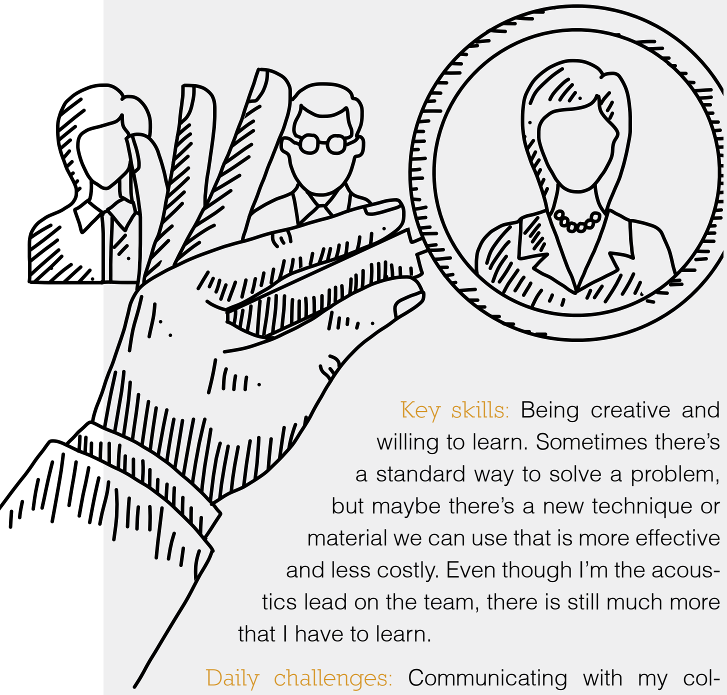
Daily challenges: I have to manage my own time and deadlines. I apply "life/work integration." Sometimes I'll work late at night or on the weekends if I know that will help me get in a long workout or take advantage of good weather to go flying. (I'm also a private pilot.)

Future plans: To keep applying the science while using my core physics education to inform the way I approach challenges. I also hope to one day own a seaplane.



BAILEY GROENDYKE, BA Music and BS Physics, Grand Valley State University, Applications Engineer, Steelcase

I am currently the acoustics lead on the Innovation Management Office team at Steelcase, which makes furniture for offices, schools, and classrooms. I specifically look into ways Steelcase can incorporate acoustics into their products, whether it be monitoring the acoustics of a space, researching new acoustic technologies for challenging areas, or applying acoustically sensitive products that improve the soundscape.



Key skills: Being creative and willing to learn. Sometimes there's a standard way to solve a problem, but maybe there's a new technique or material we can use that is more effective and less costly. Even though I'm the acoustics lead on the team, there is still much more that I have to learn.

Daily challenges: Communicating with my colleagues in non-science departments about the importance of considering acoustics. Acoustics and wave behavior in general are not always intuitive concepts for people, but they're important to take into account!

Motivation: My passion for physics has always been partly fueled by my love for music. On a more personal level, my little brother has a hearing disability. He struggles in the classroom and in other areas with poor noise control, like a cafeteria or gym. Even for those without hearing disabilities, acoustics are important. Good acoustics can be the factor in landing the big business deal over a conference call, a student learning about an important physics concept, or a patient in the cardiac ward making a full recovery. //

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5 Days Ago
Summer Research Experience for Undergraduates
MIRTHE an NSF - Engineering Research Center
New Jersey
1 Week Ago

ATTENTION PHYSICS STUDENTS: You Have Options

Q: What can you do with a physics degree?
A: Get a PhD and become a physics professor OR …

What comes after the "or" is not widely known in many physics departments, even though data show that less than a third of physics bachelor's degree recipients enroll in a physics or astronomy graduate program within one year of graduating. People with undergraduate degrees in physics pursue a variety of fascinating, fulfilling, and well-paying careers. This is evidenced by decades of data collected by the Statistical Research Center at the American Institute of Physics. Illustrated below are the common paths of physics bachelor's recipients based on the most recent data. Unless otherwise indicated, all data are for graduates of US physics programs who remain in the United States.

Over 8,400 physics bachelor's degrees were awarded in the class of 2015–16.

A record high![1] Typically…

- Three-fourths of those who earn physics bachelor's degrees have **research experience**.[2]
- One-third graduate with a **double major**, many in math.[3]
- One-tenth start at **two-year colleges**.[4]

Within one year of earning a physics bachelor's degree…

~30% attend graduate school in physics or astronomy.[5]

- About 3/4 enroll in a **PhD program**; the remainder choose a master's degree program.*
- Most are **fully supported** by teaching assistantships, research assistantships, or fellowships.

Of those who start graduate school in physics or astronomy…

~50% enter the workforce.[5]

Common employment sectors include:

Private sector
- ~2/3 of those who enter the workforce take jobs in the private sector.
- Of those that enter the private sector, the large majority hold science, technology, engineering, and math **(STEM) positions**.
- Those in private-sector STEM positions are well compensated, with a median starting salary of about **$57K**.

Colleges or universities
- More than half of the students in these positions were employed at the same institution they graduated from. Many work in research or IT.

Civilian government
- The civilian government sector includes national labs. The vast majority of these positions are in STEM fields, many related to defense or energy.

Active military
- Physics bachelor's work across all branches of the armed forces. Many work in aviation or nuclear power.

High school teaching
- About a quarter of the high school teachers indicated that their undergraduate degree had a high school physics teaching focus.

20% enroll in graduate programs other than physics or astronomy or in professional degree programs.

- About half enter an **engineering** program; the rest enter programs in math, medicine, education, or another field.[5]
- As a group, physics majors score among the highest of all majors on medical school and law school admission tests (the **MCAT** and **LSAT**).[6]
- Students in professional degree programs are more likely to be **self-funded** than students in research-based graduate programs, who usually have teaching assistantships, research assistantships, or fellowships.[5]

The Statistical Research Center does not formally follow the career paths of these individuals, but we hear that they go on to successful careers in engineering, management, education, law, medicine, business, and a variety of other areas.

Add to the mix:

Foreign citizens coming to the United States for a graduate de-gree, students who earned bach-elor's degrees in another field but want a graduate degree in physics, and students who earned a physics bachelor's degree in previous academic years.

~1 out of 6 US physics bachelor's receive a physics or astronomy PhD.*

- A doctorate in physics takes an average of **6–7 years**.[7]
- Most PhD students are **fully supported** by teaching or research assistantships or fellowships.[5]

Within one year of earning a physics PhD...

~1/2 accept a temporary position

(e.g., a postdoc), primarily at a university or with the government.[5]

~40% accept a poten-tially permanent position.[5]

- ~3/4 of new PhDs accepting potentially permanent positions are employed in the **private sector**.
- The **median starting** salary for new physics PhDs employed in the private sector is **$105K**.

Employment sectors of phys-ics PhDs 10-14 years since receiving their degree.[8]

- 45% Private sector
- 43% Academe
- 6% Government
- 6% Other

~1 out of 12 US physics bachelor's receive an exiting physics or astronomy master's degree.*

Exiting master's degree recipients are individuals who leave their current department upon receiving a master's degree. Many other students earn an en route master's degree, continuing on to a physics PhD in the same department.

- Over half of those who earn exiting master's degrees do so with a **specific research focus**.[5]
- A master's degree in physics usually takes about **two years**.

For US citizens, within one year of earning an exiting master's degree...

~1/2 enter the workforce.[5]

- About half work in the **private sector**, virtually all in STEM fields.
- The largest portion of exiting master's working in the private sector are employed in the field of engineering.
- Other common employment sectors for exiting master's in-clude **colleges and univer-sities, high schools, and civilian government.**

~1/2 continue with graduate studies.[5]

- Most transfer to other institu-tions to earn a **physics PhD**.
- Others transfer to programs in **related fields** such as materials science, engineer-ing, medical physics, and mathematics.

References and Notes

The following data references published by the Statistical Research Center of the American Institute of Physics are available online at: www.aip.org/statistics.

1. Starr Nicholson and Patrick J. Mulvey, *Roster of Physics Departments with Enrollment and Degree Data, 2016*, September 2017.
2. AIP Statistical Research Center, *AIP Physics Trends: Research Experiences of Physics Undergraduates*, Fall 2009.
3. AIP Statistical Research Center, *AIP Physics Trends: Physics Students Have Broad Interests*, Spring 2011.
4. Susan White and Raymound Chu, *Physics Enrollments in Two-Year Colleges*, April 2013.
5. AIP Statistical Research Center, data from follow-up surveys of physics bachelor's, master's, and PhDs, www.aip.org/statistics/em-ployment.
6. Casey Langer Tesfaye and Patrick Mulvey, *MCAT, LSAT and Physics Bachelor's*, December 2013.
7. Patrick J. Mulvey and Starr Nicholson, *Trends in Physics PhDs*, February 2014.

*Estimate provided by the AIP Statistical Research Center, Summer 2014.

Learn more at the Careers Toolbox website:
www.spsnational.org/careerstoolbox

AIP American Institute of Physics SPS NSF

Updated 12/2017

FEATURE

CONSIDERING A CAREER IN PHYSICS RESEARCH?

by Kendra Redmond, Contributing Writer

Whether you envision working for a college or university, national lab, private company, hospital, or other type of organization, there are a lot of ways to make research a career. It might surprise you to learn that many of these opportunities are outside of physics departments and that, in some cases, you could be competing for jobs with people who have computer science, engineering, or other specialized degrees.

For many undergraduate physics students, especially those in small departments with few faculty, research opportunities on campus are fairly limited. You can expand your exposure to different fields, tools, and techniques by pursuing research experiences and internships both on and off campus, reading about the latest developments in physics, and going to research talks and professional physics meetings. However, it can still be hard to decide what type of research you would like to pursue in graduate school (although not all research jobs require a PhD, many of them do) and as a career.

For example, if you're interested in studying gravitational waves, you might consider questions like these before approaching potential research advisors. Do you want to study gravitational waves from existing facilities? Work on plans for new gravitational wave observatories? Analyze data? Predict what gravitational wave signals will look like? Characterize or design equipment? Study the causes of gravitational waves? Predict the signals caused by such events? Write computer programs? Work on-site at a detector?

One way to break down the options in a meaningful way is to categorize research approaches as theoretical, experimental, or computational. Researchers with all three approaches often work together closely. Taking stock of your passion, personality, and skills can help you determine which type of research might be the best fit for you during graduate school and beyond.

To give you a better idea of what it means to work in each of these areas, *The SPS Observer* asked three scientists to share their stories. Since most undergraduate physics departments have at least one experimental physicist on staff, in that category we've opted to introduce you to a physicist working in applied physics, an area that falls loosely under the category of experimental physics. Like more traditional experimental physicists, applied physicists tend to be hands-on problem solvers, working regularly with data and instruments. However, by definition they focus on applying physics to real-world situations or technologies. If you would like information on what it means to be a more traditional experimental physicist, consider interviewing one on your campus or at a nearby research lab.

Research Classified

by Jess McIver, Postdoctoral Scholar in Experimental Physics at Caltech

LEFT: Experimental physicist Jess McIVer. Photo courtesy of Kent Blackburn.

This is excerpted from an article titled "From Theory to Experiment" that first appeared in the Spring 2015 issue of *The SPS Observer*.

Physics research can usually be classified as theory, experiment, computation, or somewhere in between. Each type of research has its own challenges and rewards.

THEORY

Theorists use mathematics and models to explain current phenomena, predict new ones, and describe the laws of the universe. Often these researchers tackle specific problems limited in scope, such as modeling nuanced particle interactions or predicting the amplitude of gravitational waves propagating from shortly after the big bang.

EXPERIMENT

Experimentalists test theoretical predictions as well as investigate observable interactions and physical behavior. This generally involves constructing and operating instrumentation used for measurement or observation, on a scale from the rather small (equipment that fits easily inside a small room) to the very large (e.g., the Large Hadron Collider, which has a 27-km circumference). Experimental physics often leads theory, as when a new unpredicted particle is discovered. Likewise, theory often leads experimental activities.

COMPUTATION

Computational physics is increasingly becoming a field unto itself. These researchers apply numerical analysis and other computational techniques to physics problems, including large-scale weather simulations, investigations of the properties of semiconductors, or models of protein folding. Computation has deep connections to both theory and experiment.

From the Computational Physicist

by Rajesh Sathiyanarayanan, Technical Staff Member at Applied Materials

TOP: Computational physicist Rajesh Sathiyanarayanan. Photo by Uma Ramanathan.

I had never seriously considered pursuing a career in physics until halfway through college. In the late 1990s in India, people who were good in math and science mostly went into an engineering track. Fortunately, my college provided the option of double majoring, an unusual opportunity in India, so I ended up studying physics and computer science. This naturally paved a way for me to go into the field of computational physics later. Although I was initially inclined towards working on theoretical cosmology in graduate school, funding scenarios and job prospects in that field made me change my mind. After talking to faculty members from different research groups, I decided to specialize in computational materials science.

Broadly speaking, computational physicists use simulations to provide a reasonably accurate description of systems that are either too complex for a purely theoretical treatment or require considerable cost and time to study through experiments. For instance, the question "How do atoms arrange themselves at the interface when two solids are brought together?" can be answered relatively easily through a computational approach. In computational materials science, simulations help users evaluate different materials to identify the one(s) with desirable properties. Simulations are also being used to design materials with desired properties. As a result, this field has found applications in a lot of industries, ranging from aerospace to fabrics.

After my PhD and a short postdoctoral stint, I got a research position suited to my background in the semiconductor industry. For the past several decades, Moore's law, i.e., the doubling of transistor density approximately every 2 years, has been the guiding principle in the semiconductor industry. Of late, materials innovation has played a huge role in helping semiconductor technologists keep up with Moore's law. My job involves performing simulations to screen materials that could lead to better semiconductors.

There are multiple options in industry for people who want to pursue a career in computational physics research. Physicists are a well-sought-after group, mainly due to their strong mathematical training and analytical skills. A little bit of coding knowledge further enhances one's job prospects. This does not require much extra effort, as most data collection and analysis work in graduate school involves writing scripts—a great way to hone your coding skills. Across industries, I see an increasing reliance on computer simulations to understand and verify ideas before building actual prototypes, and I think it is a great time to get into the field of computational physics, especially if one is interested in a career outside of academia.

From the Theoretical Physicist

by Bret Underwood, Associate Professor at Pacific Lutheran University

"Hmm…What now?" It's a familiar feeling, being stumped on a physics problem, not sure what to do next. But this was a different type of problem. As a junior physics major, I was strongly considering graduate school in physics. I enjoyed studying physics and had some research experience as an undergraduate. But I was a little intimidated by the graduate school application process. What field should I study?

I read about current research areas on faculty webpages and in journals like *Physics Today* and realized I was most excited about particle physics and cosmology. However, I was not particularly confident about my laboratory skills (perhaps my instructors felt the same way), so I felt theoretical physics was a better fit. I talked with my faculty mentors about graduate school and the application process, and discussed my sketched-out plans with my fellow students. I learned that graduate school was not just going to be more physics classes, but would also require me to take a much more active role in creating new physics. I thought that sounded pretty cool, so I chose some graduate schools that were doing things I was excited about and submitted my applications.

In graduate school, I began studying problems like a theoretical physicist, refining the same skills I used in my graduate school decision: reading, learning new ideas and techniques, and discussing with others. For example, my first research project involved studying the aftermath of a string theory model of a period of the early universe that underwent a very brief rapid expansion called inflation. In order to understand this model, I had to learn general relativity, string theory, and relativistic field theory, as well as the more specific topics of inflation, D-branes, Kaluza-Klein modes, and postinflationary reheating. If you don't know what most of these things are, that's okay—I didn't either at the time. Stacks of books and journal articles covered my desk as I read, reproduced calculations, discussed with my advisor and other students, and generally tried to figure out what calculations of my own I could do. I might occasionally use a computer program to do some particularly nasty algebra, but mostly I did long calculations that I checked against existing results in the literature and then extended into new results. Eventually, with guidance from my advisor, I found a way to combine these ideas from different areas of physics into a single model.

Today, as a professor at a liberal arts college, I still use the skills of a theoretical physicist, whether I'm working on a research project or revising my teaching. Reading the literature, learning new ideas and methods, and discussing with colleagues are essential techniques for me anytime I'm facing that familiar question: "Hmmm…Now what?"

LEFT: Theoretical physicist Bret Underwood (right) and former student Auberry Fortuner (2013) explore the physics that gave rise to the expansion of the universe. Photo by John Froschauer, Pacific Lutheran University.

RIGHT: Medical physicist Jasmine Oliver. Photo courtesy of Jasmine Oliver.

From the Experimental/Applied Physicist

by Jasmine Oliver, Medical Physics Resident at Orlando Health UF Health Cancer Center

I was initially introduced to medical physics at South Carolina State University at a summer orientation for incoming freshman. I was a biology major with plans to attend medical school until a talk on medical physics piqued my interest. I left the orientation and mulled over my options for the remainder of the summer. When I returned in August, I was a physics major. I reasoned that a physics degree could work for either medical school or medical physics, and by the beginning of my senior year at SC State, I'd decided that medical physics was the field for me. Fast-forward through graduate school in medical physics and a postdoctoral fellowship, and now I am a medical physics resident at the Orlando Health UF Health Cancer Center. This is a two-year training position for medical physicists and a requirement for the American Board of Radiology certification in medical physics.

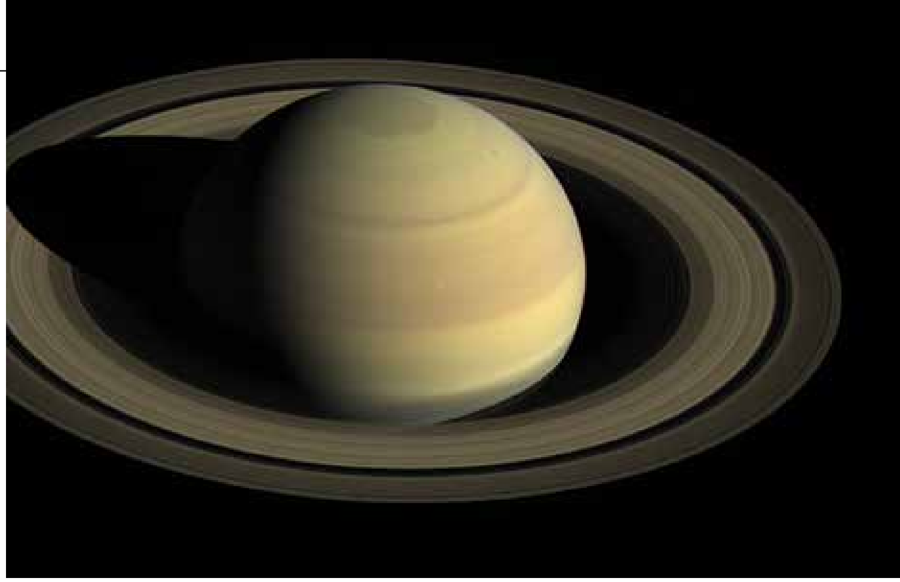
Medical physics falls into the subdiscipline of applied physics. An applied physicist is a physicist who applies physics principles to practical situations. For example, as a medical physicist I apply physics concepts to treat cancer patients with radiation. Applied physics is a bridge between physics and engineering. Applied physics research differs from "pure physics" research because it is being applied in real-time for practical use. "Pure physics" research forms the fundamental basis for applied physics research.

Although the work environment is different, there are many similarities between applied physics and experimental physics. Both are hands-on areas that commonly require scientists to calibrate, operate, and troubleshoot equipment. Both fields value people who can assess data quickly and solve problems creatively. The ability to work well with others on a common goal is essential, whether that be most effectively treating a patient or detecting gravitational waves.

IF YOU ARE INTERESTED IN PURSUING A CAREER IN EXPERIMENTAL OR APPLIED PHYSICS RESEARCH, HERE'S SOME ADVICE:

1) Do your research (no pun intended). Google various physics subdisciplines and talk with people in those fields, if possible. Even better, make an effort to shadow these professionals or at least visit their labs. Apply for internships and research experiences in your top fields. Be sure to consider salary, work/life balance, job availability, and location of available positions in your decision-making process.
2) Begin developing the necessary skills for your future position now. Take as many math, physics, lab, and related courses as possible. Expose yourself to as much knowledge as possible and look for connections between disciplines. In my experience, I have found that areas of physics where I connect the dots with other science disciplines (e.g., chemistry) are easier to fully comprehend.
3) Begin thinking and acting like a scientist/researcher now. Analyze situations and challenge yourself to creatively solve problems using the resources you have on hand. //

SPECIAL FEATURE



THE END OF AN ERA: A FIERY FAREWELL TO CASSINI

by William Miller, Physics and Math major, University of Idaho

Since entering orbit around Saturn in 2004, the Cassini probe has provided tens of thousands of images of Saturn, its rings, and its moons—countless glimpses that have elevated our understanding of these bodies in invaluable ways. Cassini was equipped with six remote sensing instruments that imaged in the ultraviolet, visible, infrared, and radio spectra, and six other instruments to analyze the dust, plasma, and magnetic fields around Saturn. Those images have revealed methane lakes and rivers on Saturn's largest moon, Titan, and cryovolcanoes spewing water from another of its moons, Enceladus. These discoveries have raised the possibility of subsurface oceans on the two satellites, which are of particular interest because they could both harbor life.

In 2017 Cassini began its final chapter. Running out of fuel to maintain its orbit, Cassini's mission scientists did not want to risk contaminating Titan or Enceladus by impacting them with microorganisms from Earth. Instead, they set Cassini on a collision course with Saturn, to burn up in the atmosphere. After one final close flyby of Titan, Cassini's orbit was reshaped to dive between Saturn and its rings 22 times before finally plunging into Saturn's atmosphere on September 15.

Cassini was a collaboration between NASA, the European Space Agency, and the Italian Space Agency. However, many research groups across the world have been, and still are, involved in analyzing the data from Cassini. I work with Dr. Jason Barnes at the University of Idaho, using images from the Visual and Infrared Mapping Spectrometer (VIMS) on Cassini to map the surface of Titan.

Titan's atmosphere is too dense for us to see the surface in the visible spectrum, but there are five "atmospheric windows" in the infrared spectrum, ranges of wavelengths to which the atmosphere is nearly transparent. We use these five bands to map the surface by combining the data in these wavelengths from hundreds of images to create a single composite. These composites show methane lakes and evaporites, massive dunes of hydrocarbons, and ice mountains. They offer the most complete and detailed glimpses of Titan's surface that Cassini could provide.

The process to reduce a set of images to a single map is computationally intense. From start to finish, it can take a week to generate a single map. It also requires a significant and specialized computing infrastructure, meaning there are few labs which can create these composites. The goal of my work is to create a publicly available set of maps for each flyby to help preserve the legacy of this voyager and to enable future research about Titan's surface. //

TOP LEFT: A false-color image of Titan in the infrared spectrum made by a former student of Dr. Jason Barnes at the University of Idaho, working on the same project as Miller. Credit: NASA, JPL-Caltech, University of Arizona, University of Idaho.

TOP RIGHT: With this view, Cassini captured one of its last looks at Saturn and its main rings from a distance. Credit: NASA/JPL-Caltech/Space Science Institute.

ABOVE: William Miller. Photo courtesy of the author.

ONCE AGAIN, LIGO MAKES HISTORY

FROM LEFT TO RIGHT: David Reitze, France Córdova, David Shoemaker, Jo Van Den Brand, Laura McKinney, Maricio Branchesi and Vicky Kalogera. These individuals spoke on a panel discussing Gravitational Waves detection and the initial EM observations. Photo courtesy of Maya Kinley-Hanlon.

SPECIAL FEATURE

by Maya Kinley-Hanlon, SPS Member, American University

This summer, LIGO once again made history. The Laser Interferometer Gravitational Wave Observatory saw signals from two neutron stars colliding, the morning of August 17, 2017. As a student reporter for *The SPS Observer*, I got to attend the official announcement of the discovery on October 16th.

It was thrilling to be in the same room as 30 journalists from such a wide array of publications. I was sitting next to a reporter from the *LA Times*. None of us, at the time, knew what would be announced, simply that it was a discovery that would rock the astronomical community. Suddenly, a hush came over the room as the panelists silently filed in. After the introductions were made, France Córdova, Director of the National Science Foundation (NSF), took the podium. "Today," she said, "we are thrilled to announce that scientists have detected gravitational waves coming from the collision of two neutron stars."

David Reitze, executive director of the LIGO lab at Caltech, then took the podium. "We have, for the first time, seen both gravitational waves and light from the collision of two dense, dense, stars," he said. "This time…we all did it." It is that message that resonated as each panelist spoke. What was possibly the most amazing feat of this discovery is not just its impact, but also the fact that it was a collaboration between LIGO, VIRGO, and over 70 astronomical observatories in the world, with both ground- and space-based detectors.

LIGO deputy spokesperson Laura Cadonati mentioned that nature has been benevolent with LIGO throughout the entire process. The strong initial signal of two black holes merging was a clear announcement to the world that the science of LIGO was successful. And while the detection of a binary neutron star merger was an expected detection, it announced a revolutionary new era of multi-messenger astronomy. The binary neutron star merger was the first to be seen and gave a description for the amount of gold and platinum that exists in the universe. Additionally, because neutron stars are so dense, their collision is bright and able to be seen by not only gravitational wave detectors, but by telescopes around the world, including gamma-ray and x-ray detectors. Being able to study this event by looking at gravitational waves and light together will allow astronomers to learn even more about our universe.

The LIGO Collaboration has grown up over the past 40 years, along with the researchers who have dedicated their lives to it. Until the initial discovery of gravitational waves in 2015, LIGO efforts were hardly known by the public and viewed with skepticism by more established astronomy communities. The researchers of LIGO pushed on, not because they hoped to gain fame, but because they believed in what they were doing. This made the collaboration one of community and support, which was clearly evident during the press conference. Every scientist on the LIGO panel echoed each other that this most recent discovery was one made and celebrated by a community.

After a celebratory dinner, I sat with astronomer and researcher Vicky Kalogera and Laura Cadonati, talking about the importance of such a large collaboration. Kalogera, who came from a pure astronomy background, talked about how before she joined LIGO she was used to very small groups, and she grew to understand that you cannot achieve results like these without a collaboration of this size. "No individual group can reach this kind of achievement," she said. "We need each other."

Towards the end of dinner, Cadonati and LIGO spokesperson David Shoemaker were pushed to give a toast. "This is a celebration of a remarkable result of observations of LIGO, and a really joyous combination of both this collaboration and our electromagnetic partners that has turned out remarkably well," Shoemaker said.

Cadonati added, "We want to thank you for this amazing endeavor…It has not always been easy, but the very fact that we got 3500 authors on the same paper, 70 papers in the archives today, and we took down the journal web servers," she said to cheers and applause from the room, "is an amazing accomplishment. I look forward to all of you giving talks to the general public and raising enthusiasm for gravitational wave astrophysics, gravitational wave cosmology, gravitational wave nuclear physics, and the good things that will come. Thank you everyone, and welcome to the new era." With that, the room erupted into thunderous applause.

What keeps LIGO researchers going is the hunt for more discovery. Kalogera put it simply: "No matter what, research is about questions." This is what we can all keep in mind as we find the efforts we want to dedicate our lives to. I'm thankful to have begun my career in research within the LIGO Collaboration. Hopefully, no matter what we choose to study, we are surrounded by as much support and joy as LIGO has had. //

PHYSICS IN THE NEWS

3 RECENT DEVELOPMENTS YOU SHOULD KNOW

by Rachel Kaufman, Editor

Here's a brief update on some new and exciting developments in the world of physics.

LIGO PIONEERS AWARDED NOBEL PRIZE

The Nobel Prize in Physics in 2017 went to Rainer Weiss of MIT, and Barry Barish and Kip Thorne of Caltech for their leadership making LIGO a reality. The three scientists delivered their Nobel Lectures Dec. 8 in Stockholm.

In some ways the announcement was no surprise, as the excitement around LIGO had been building since the group announced in February 2016 it had observed gravitational waves from colliding black holes. That discovery, which the Royal Swedish Academy said was "a discovery that shook the world," confirmed a key part of Einstein's theory of relativity and has the potential to lead to entire new branches of science. Since the initial detection, which occurred in September 2015, LIGO has detected at least four more pairs of black holes colliding.

Not to rest on their laurels, just two weeks after the prize announcement, the LIGO Collaboration announced it had observed two neutron stars colliding.

Read Maya Kinley-Hanlon's article on page 25 for more details.

TINY QUANTUM FIREWORKS EXPLODE OUT OF LAB

University of Chicago researchers studying Bose-Einstein condensates have discovered a new quantum behavior.

Physics professor Cheng Chin and his team cooled bosons down to nearly absolute zero. When atoms are cooled to extremely low temperatures, they "clump" together and behave as if they were one atom. (It's weird behavior, and the first Bose-Einstein condensate won its creator a Nobel Prize in 2001.) In Chin's lab, they created the condensate, then jostled the atoms until they collided and flew out of the condensate. Instead of seeing random ejections, they saw "jets" of atoms flying together, like tiny fireworks. Those jets are composed of thousands of atoms, so "It's like people forming a consensus and leaving in groups," Chin said in a press release.

What causes this behavior is not yet well understood but could someday be useful for building new technology.

Read the paper describing the phenomenon in ***Nature***: DOI: 10.1038/nature24272.

STEPHEN HAWKING'S THESIS GOES VIRAL

Dr. Stephen Hawking's 134-page PhD thesis, "Properties of expanding universes," has long been the most requested item at the Cambridge library. Last fall, Hawking gave his permission for his thesis to become open access—freely available to download for all.

Just a few hours after the thesis went open access, the demand of 60,000 people trying to get it caused parts of Cambridge's website to crash.

"It's wonderful to hear how many people have already shown an interest in downloading my thesis," Hawking told the BBC. "Hopefully they won't be disappointed now that they finally have access to it!"

If you haven't yet read the work, you can download it, free, in high-resolution from https://cudl.lib.cam.ac.uk/view/MS-PHD-05437/1. //

COFFEE PHYSICS

The physics world was (justifiably) excited by the announcement in October that the 2017 Nobel Prize in Physics went to the architects of the Laser Interferometer Gravitational-Wave Observatory. But careful observers also noticed another stimulating physics award given this fall: the fluid dynamics Ig Nobel, given to college student Jiwon (Jesse) Han for a paper on why coffee sloshes so much in your mug. The Ig Nobel awards are given every year to research that makes "people laugh, then think."

Han was a high school student when he authored a paper highlighting a number of methods for saving your cuppa from landing on your shirt front—something that should be a benefit for physicists everywhere, since many physicists run on caffeine!

First, he looked into why coffee is so prone to spilling in the first place, using a smartphone's accelerometer to measure the forces in play. This built off 2012 work by H.C. Mayer and R. Kretchetnikov that found that the frequency oscillation of coffee rocking back and forth in an average mug matches a typical person's walking speed. Thus, every step you take holding a coffee mug amplifies the slosh, until—Argh! (Kretchetnikov's research won its own Ig Nobel in 2012 and ended up on a list of "wasteful projects" compiled by Sen. Jeff Flake. Guess you can't please everyone.)

The Resume:
Your Key to Employment

by Kerry Kidwell-Slak, Assistant Director, Society of Physics Students and Sigma Pi Sigma

Whether you are seeking a part-time job, undergraduate research position, summer job, or a full-time career, most prospective employers are going to want to see a resume. A resume is a short summary of your most relevant qualifications for a particular employment opportunity. Notice that there are a few important qualifying words in that definition. Let's break them down:

Short: For most undergraduates, your resume should be one single side of a piece of paper. A typical employer is going to spend less than 30 seconds looking at it and making their first impression of you. That means you need to focus your resume, not overload a hiring manager with unnecessary words. Also, be selective and consistent with your use of text formatting—no need for five fonts or multiple styles of bullet points.

Most relevant: A resume is not a broad, divergent x-ray beam showing everything you've ever done. Think of it more like a pinpoint laser—narrowly focused on communicating those qualifications that highlight your potential value to an employer. Pick and choose the skills and experiences that paint the best picture of you for the reader. For example, if you are applying for a job as an outreach coordinator at a science center, you may not want to use a precious two lines listing all the programming languages you know, but rather describe the outcomes of the amazing eclipse event you coordinated (i.e., "Recruited, trained, and coordinated 50 student volunteers for a solar eclipse outreach event that attracted 750 elementary school students"). Save the programming languages for that intriguing software job. Similarly, when discussing your research, don't simply restate your research question. Discuss what your contributions were to the project and how you made an impact (e.g., "Fabricated superconducting films and tested their mechanical properties using a range of instrumentation").

Particular: You should have a unique resume for each employment opportunity you are seeking. This can't be overstated enough. What someone hiring for an entry-level analyst position is looking for is very different from what someone hiring for a research assistant is targeting. Read job descriptions carefully before you begin to write so you know what to include in your document. By having only one resume that you think everyone will be interested in, you are not making the most of the opportunity a resume provides. Even at a large event like a career fair, research the types of jobs you think you might encounter in advance and be ready with different versions to support different employers' needs.

With these tips in mind, start seeking out job advertisements that interest you, recall your experiences that seem to fit, and begin to write! Don't worry if your first draft runs long, just put it all on paper. You can edit and refine later. Your campus career services office can be a great partner in this effort. They have worked with thousands of students in your situation and can give you guidance. Also think about others whose opinions you respect and ask them to give you feedback—this may be your faculty advisor, SPS mentor, past supervisor, or other professionals in your network. Ultimately, though, the document is yours alone, so consider their opinions, but make sure the final product is something you are comfortable with and represents you accurately.

Your resume is the first step in your relationship with an employer. By following this advice, you will hopefully get them excited about your qualifications and experience and land an opportunity to interview. //

FOR MORE INFORMATION ON RESUMES AND THE JOB SEARCH PROCESS, CHECK OUT THE SPS CAREER PATHWAYS PROJECT: **www.spsnational.org/careers**. Your chapter can order interactive Career Toolbox workbooks to guide you through the job search process and lead to employment success!

After Han established why coffee spills in the first place, he came up with a number of solutions. Walking backwards is one. Most people's walking frequencies are different, or at least less regular, when they walk backwards (unless they're Ginger Rogers). Of course, walking backwards might not be an ideal solution. As the paper notes, "walking backwards...drastically increases the chances of tripping on a stone or crashing into a passing colleague who may also be walking backwards."

Another solution is to use the "claw grip"—carrying your mug by the top. Han modeled holding a mug by its handle as a simple pendulum. Holding the mug by grasping it from the top turns it into a double pendulum, which suppresses the resonant effect.

Han came up with a number of other, even less practical solutions as well. Dividing the cup into 20 or 30 tiny cylinders changes the resonance of the container, but drinking out of such a cup would be impractical to say the least. A thin layer of foamy soap also dampened the sloshing, but who wants to drink coffee with a layer of soap bubbles? (No word yet on whether foamed milk can save your coffee.)

In the end, the simplest solution may be the one Han gave during his Ig Nobel acceptance speech in September: "For those who do not want to spill their coffee, that's why the lid was invented." //

Biophysics Researchers Receive the 2016 -17 SPS Awards for Outstanding Undergraduate Research

The SPS Award for Outstanding Undergraduate Research is presented each year to SPS students who demonstrate exceptional research achievements in a physics-related field. Awardees receive a $500 honorarium for themselves, $500 for their SPS chapter, and funding to present their research at a professional physics meeting. SPS is pleased to introduce the most recent winners, Matthew Huber and Kathryn Regan. For more details on the award and recipients, visit the SPS website at https://www.spsnational.org/awards/.

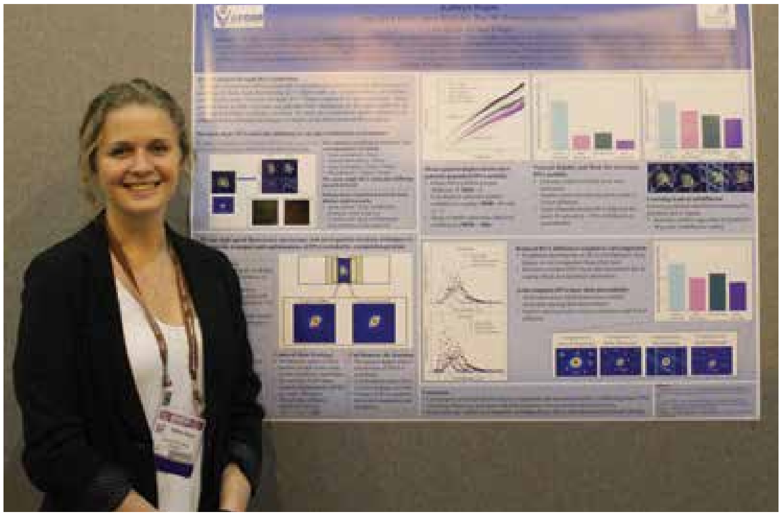
MEET MATTHEW HUBER, RHODES COLLEGE:

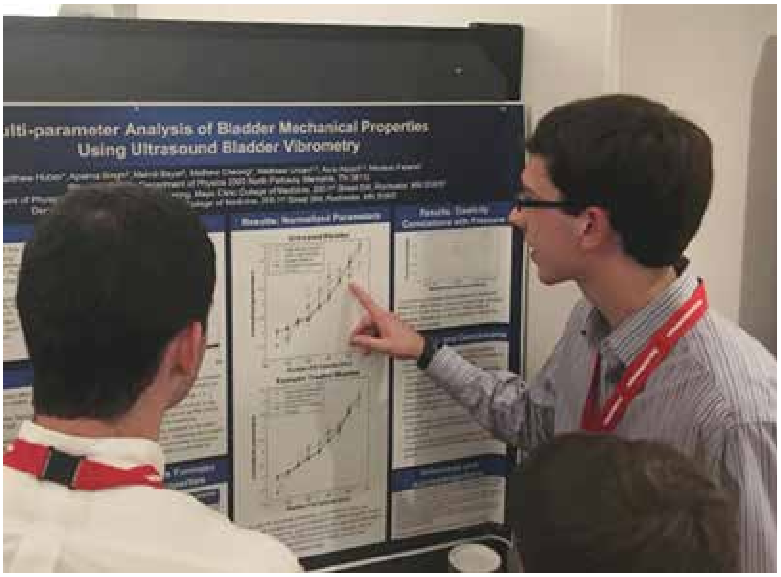
I have always had an interest in physics. Applications of physics in biology and medicine are particularly exciting to me because of the ways physics can enhance these fields and improve lives. Fortunately, the physics department at Rhodes College excels at giving students opportunities to explore their interests and become engaged outside of the classroom, enabling me to begin doing research the first semester of my freshman year.

My undergraduate research has focused on exploring new methods and techniques for using ultrasound in clinical applications. At Rhodes College, I worked on ultrasound backscatter techniques aimed at diagnosing osteoporosis. I also spent summers at the Mayo Clinic and Duke University, where I worked on projects contributing to ultrasound measurements of bladder compliance and prostate cancer, respectively.

The work I did leading up to this award came about because of my previous ultrasound experiences. Because ultrasound can't be seen without complex modeling, it can be difficult to understand how it interacts with materials. In search of a technique that could be used to visualize ultrasound, I initiated a joint effort between Rhodes College and Gustavus Adolphus College to utilize refracto-vibrometry for biomedical ultrasound applications.

Refracto-vibrometry uses a scanning laser Doppler vibrometer to detect the phase shifts of light as sound passes through a laser beam. This allows you to "see" how ultrasound waves propagate through optically transparent media as a laser is scanned through a field. In this study, we visualized ultrasound fields interacting with a heel bone. Ultrasound heel bone scans are currently used to screen for osteoporosis. Since our refracto-vibrometry studies improve understanding of the complex interaction of ultrasound with heel bones, they can potentially provide insight on how to improve these scanner systems.





FAR LEFT: Award recipient Matthew Huber. Photo courtesy of Rhodes College.

LEFT: Regan presenting her research at the 2017 American Physical Society March Meeting in New Orleans, Louisiana. Photo by Devynn Wulstein.

BELOW: Huber presenting his research at the 2016 Quadrennial Congress of Sigma Pi Sigma (PhysCon) in San Francisco, California. Photo courtesy of Rhodes College.

Huber will be presenting his award-winning research at the American Physical Society March Meeting in Los Angeles, CA, in March 2018.

MEET KATHRYN REGAN, UNIVERSITY OF SAN DIEGO:

I'll be honest. I had a love–hate relationship with physics in high school. However, when I came to my university I realized how much I really loved physics after all: The basic explanations found in introductory courses were a source of comfort during a difficult transition. Biophysics drew me in because it combined my love for the natural sciences with the specific type of thinking found in physics. I realized I could learn a little bit of everything and use it to understand the natural world.

Understanding how DNA behaves in cellular environments has valuable implications for better characterizing DNA behavior as a whole and, therefore, helping us develop better drug delivery and gene therapy technologies. My research focuses on investigating the dynamics of DNA in crowded environments like the inside of cells. I focus on crowding by two cytoskeletal proteins, actin and tubulin. In this research, I isolated and purified stocks of DNA at a known length (4 μm–100 μm), conformation, and concentration, and then used fluorescence to track how the shape and dynamics of those DNA molecules changed as they diffused among the proteins.

The most challenging part of this research involved optimizing protocols for the DNA. I needed to find where the DNA was happiest, while considering the fact that actin and tubulin also have their own optimal environments. The most rewarding part was when I managed to fine-tune those conditions and image my fluorescing DNA within its protein environments.

I have grown tremendously as a result of the mentoring I have received over the last four years. I aim to continue this tradition of mentorship with the physicists and biophysicists around me. My hope is that this award will not only inspire me but others as well.

Regan will be presenting her award-winning research at the Annual Meeting of the Biophysical Society in San Francisco, CA, in February 2018. //

TO APPLY FOR THE SPS OUTSTANDING UNDERGRADUATE RESEARCH AWARD AND ALL SPS AWARDS, PLEASE VISIT: www.spsnational.org/awards

Tips for Hosting a Zone Meeting

by Nickalaus Clemmer, SPS Member & AZC Zone 14, Colorado Mesa University

Zone meetings are an exciting opportunity for you to attend a regional, physics-inspired gathering for all the chapters in your zone to meet the other SPS members in your zone and to learn from other chapters. At the meetings you also have an opportunity to present your research, view other research, explore campus labs, and develop professional relationships at one of the best networking opportunities for physics undergraduates. There are numerous benefits in attending a zone meeting, and all SPS members should make it a point to attend them as frequently as possible.

One way to make sure you can attend a zone meeting is to host it at your university. Hosting at your university has all the advantages of going to a zone meeting but adds the additional benefits of not having to travel, the opportunity to show off your university, and the opportunity to participate in a significant way within your zone.

You may be wondering what you will need to do to prepare for such an event. Fortunately, there is a list of simple steps that will help guide you through the process of hosting your zone meeting, making it as fun and stress free as possible.

First and foremost: Contact your zone councilor or associate zone councilor.

Getting in contact with your National Council representative is definitely the first step when you are planning a zone meeting. Your AZC and ZC will have the resources and information to help you plan and organize your event and will be able to advise you if there are any other chapters in your zone that have already requested to host the meeting in the year in which you are interested. Some zones will host two meetings a year, meaning that you have twice the opportunity to schedule a meeting. You can find contact information for your ZC and AZC on the SPS National website, www.spsnational.org/about/governance/national-council.

Once you have secured your spot for the zone meeting: Set a date.

Having a set date for the zone meeting as quickly as possible is important so that everyone in your zone can start planning their schedule around that date. Make sure that you host your meeting at a time that is convenient for your university, professors, and classmates (as well as the other chapters in your zone) so that you can get as much help organizing and setting up the meeting as possible. Generally, having other schools arrive on Friday and

having the bulk of the meeting on Saturday works best. Once you have your date established, contact SPS National to have your zone meeting date saved and published. Your AZC and ZC are great resources here.

Next: **Contact the chapter leadership in your zone.**

Zone meetings are about bringing together all of the chapters in your zone, and you need to make sure that each of the chapters in your zone are invited to the meeting. Doing this step as soon as possible provides the chapter leadership in your zone ample time to make preparations to attend. A "save the date" email is recommended as a first point of contact. You can follow up with additional information about the itinerary and logistics (such as lodging and food) later.

Then: **Make a schedule.**

Having a tentative schedule in the works from day 1 will aid you in planning. Once an agenda is in place, send it to the other chapters so that they, too, can prepare. Activities on the schedule are up to the individual chapter and university, although there are some suggested items that you should consider as part of a standard meeting.

Take a look at the list below of suggested events and activities for your zone meeting:

Most zone meetings should provide an opportunity for undergraduate research poster/paper sessions. One of the best aspects of a zone meeting is having the opportunity to show your research to a group of peers. Therefore, there should be some time allotted to a student research session.

Some form of campus or lab tour is also recommended. Many of the people that are coming to your meeting will be unfamiliar with your specific university, and this will be a great opportunity to show them what your school has to offer. Having professors present research and labs is an exciting way to introduce SPS members in your zone to the research taking place at your school.

Schedule a seminar. Whether you invite an outside speaker or one of your faculty members wants to present, planning a time for people to learn something new is an important and exciting part of the zone meeting.

Several items in the schedule will require funding, so the next step is: **Request funding from SPS National.**

SPS National is a significant resource when hosting your zone meeting and will also aid you in funding the meeting. You will have the opportunity to apply for funding to help you pay for expenses that your chapter may not be able to otherwise afford. To learn more about funding your zone meeting, visit the SPS National website, https://www.spsnational.org/meetings/zone-meetings/funding.

Another important step: **Recruit help from other members in your chapter.**

Hosting a zone meeting is not an easy task, and asking for help from your peers and department will be necessary. Make a list of items that need to be completed so you can easily delegate tasks. Make sure that there are set times for goals to be completed and that all participants have a calendar of these dates.

The final step: **Have the zone meeting!**

This is the fun part. All the hard work and preparation that you have done will finally come to fruition when you are able to have everyone together to enjoy a fun and exciting day of physics and camaraderie. You will still need to keep things organized and on schedule, but do not forget that you are there to enjoy this event as well.

Go to the SPS National website for more information about hosting zone meetings.

This guide is a brief introduction to what you should do when preparing for a zone meeting, but there are plenty of things that will be unique to your specific meeting. For a more complete list of things to do before hosting a zone meeting, go to the SPS National website to view the hosting a zone meeting checklist. If you still have unanswered questions, contact your AZC or ZC for more information.

Good luck! //

TOP LEFT: Zone 14 SPS members pose with Dr. Eric Cornell (pictured second from the right, front row) after his seminar in March 2017. Photo courtesy of Colorado Mesa University SPS Chapter.

ABOVE: Nickalaus Clemmer. Photo courtesy of the author.

To learn more about SPS regional zones and their meetings, visit https://www.spsnational.org/meetings/zone-meetings.

The 2017–18 SPS Guiding Priorities

by Samuel Borer, AZC Rep, University of Maine

This past September, SPS faculty and student leaders from around the country converged at the American Center for Physics for the 2017–18 National Council Meeting. At the beginning of the academic year, the National Council meets in person to strategize and plan for the success of SPS throughout the next year. For most associate zone counselors, who serve one-year terms, it was our first time on the National Council and the meeting offered us the chance to get acquainted and form close friendships with the people we would be working alongside for the next year. For others, it was a reunion of old friends, a time to exchange cherished memories and reminisce about their histories within the organization.

The major focus of the National Council meeting was to discuss the Society of Physics Students' guiding principles for the upcoming year. We came up with three goals for the upcoming academic year: 1. improving communication among chapters, zones, and the National Office, 2. promoting professional development, and 3. integrating diversity and inclusivity into our chapter operations.

Here's what those goals mean.

1. IMPROVING COMMUNICATION AMONG CHAPTERS, ZONES, AND THE NATIONAL OFFICE

No SPS chapter lives in a vacuum. One of our greatest strengths as an organization is that we connect physics majors from across the globe to each other and to the professional physics community. Through the zone system, SPS chapters have access to regional assets and a local community of physics enthusiasts. Each chapter has a connection to the National Office through its zone, where they can take advantage of national resources, scholarships, professional development opportunities, and more.

Throughout the next year, we will make an active and directed effort to

ABOVE: The SPS National Council applauds Earl Blodgett, SPS & Sigma Pi Sigma Historian, during the 2017-18 Fall National Council Meeting. Photos courtesy of Hyun Joo Kim, AIP.

TOP LEFT: The entire SPS National Council poses outside of the American Center for Physics. Photos courtesy of Hyun Joo Kim, AIP.

BOTTOM LEFT: Samuel Borer. Photos courtesy of the author.

reach all corners of the SPS network to establish or improve upon existing routes of communication. Establishing lines of communication that will outlive the flux of SPS chapter leadership will help us ensure we maintain contact with every chapter as they evolve and grow. This will also give every local SPS chapter unfettered access to amazing resources to enhance their chapters and improve their members' experiences. To contact your zone councilor or associate zone councilor, visit the National Council directory at www.spsnational.org/about/governance/national-council.

2. PROMOTING PROFESSIONAL DEVELOPMENT IN OUR CHAPTERS

In today's competitive job and graduate admissions climate, having a bachelor's degree is barely enough to get your application considered. Employers and admissions committees consistently say that they want college graduates who are able to present their education, experience, and skills effectively. These are not topics commonly found in your electricity and magnetism syllabus!

This is an enormous opportunity for SPS to bridge the gap and provide our members with professional development. The National Council wants to work to find ways to encourage every local chapter to introduce more professional development into their operations. Consider holding a resume workshop, an interview prep session, networking opportunities, or graduate school application assistance. The SPS National Office, your school's career center, and local alumni can be great partners in this effort.

3. INTEGRATING DIVERSITY AND INCLUSIVITY INTO OUR CHAPTER OPERATIONS

Scientific exploration is, at its very core, a human endeavor. It underpins who we are as a species and it knows no division. The Society of Physics Students promotes, supports, accepts, and respects everyone who wants to join our community of science-lovers.

The National Council declares that discrimination, intolerance, or hatred should not be permitted in any magnitude. We celebrate differing opinions and welcome civil discourse. We foster respect and understand the importance of working to understand those around us. Our chapters will foster an outlet for expression—an environment where every member feels safe and welcome and has resources available to them to succeed. These are values held dear by the Society of Physics Students at every level of our community. To read the SPS Statement on Diversity and Inclusivity, review www.spsnational.org/about/governance/statements/sps-statement-diversity-and-inclusivity.

It has been an absolute honor to serve on the National Council thus far and I am looking forward to the remainder of my term. The National Council is here to help you and your chapters with anything we can, and we would love to hear from you. You can identify your National Council representatives at www.spsnational.org/about/governance/national-council. If you are interested in serving on the National Council, review the descriptions of open Council positions and fill out the nomination form by visiting www.spsnational.org/about/governance/national-council/nominations-elections. //

Zone 13 – Joint APT, AAPT, SPS Meeting

by Daniel Morales, SPS Member & AZC Zone 13, Texas Lutheran University

This fall, the 2017 joint meeting of APS, AAPT, and the Society of Physics Students was held in Richardson, Texas, at the University of Texas at Dallas from October 19th through October 21st. On the 19th, eight members of our chapter began the 4-hour drive from Seguin, Texas, representing Texas Lutheran University.

The first day of the event began for us on the 20th. The day started with tours: Participants could visit either the university's $85 million Natural Science and Engineering Laboratory for materials science or the William B. Hanson Center for Space Sciences. While in the NSERL, we learned about the different deposition/fabrication processes of thin films/semiconductor materials at high temperatures. We learned about the relationship between UT Dallas and their close friends at Texas Instruments, where many TI employees have gone on to become research associates/lab technicians at UT Dallas and vice versa.

Once the tour was over, we were led back to the main conference area for networking, posters, and talks.

Throughout the event, six speakers were invited to talk: Prof. Allan MacDonald, Prof. Dean Sherry, Prof. Karl Gebhardt, Prof. Lisa Whitehead Koerner, Dr. Moogega Stricker, and Prof. Vernita Gordon. Their talks ranged from biophysics to particle physics to the Mars 2020 mission and the importance of planetary protection.

The second day of the event, we held the sessions on various physics topics given by undergraduates, graduates, and faculty. Prizes were awarded for the best talks of each session, which motivated everyone to bring their A game! SPS sessions were held for undergraduates, while there were separate sessions for those looking into more specific areas of physics like nuclear, astrophysics, biophysics, materials, particle physics, and much more.

Overall, the meeting was a great success for everyone who attended. There were plenty of activities throughout the event and great talks given by talented speakers. Attending the Zone 13 meeting was a great experience, and it really inspired others to take part in SPS events, as well as shape career paths for those who were able to explore different areas of physics that they may not have known existed. //

ABOVE: The Texas Lutheran University chapter of Zone 13 visiting the AAPT/APS/SPS Texas Section Meeting in Richardson, TX. Photo Courtesy of Daniel Morales.

The Society of Rheology Outreach Event

by Keegan Karbach, SPS President, Metropolitan State University of Denver

In early October, we had the wonderful opportunity to do a children's outreach event in conjunction with The Society of Rheology at the Denver Children's Museum. This was a multichapter partnership, with three SPS chapters represented: the University of Colorado, Denver, the Metropolitan State University of Denver, and the University of Denver. There were approximately 15 members of The Society of Rheology who came in from around the world as well.

We set up a variety of different demonstrations of nonintuitive fluid mechanics, targeted at kids ages 5–12. These demonstrations consisted of a variety of non-Newtonian fluids that had unusual physical properties intended to challenge the children's intuition. We had hydrogels, slimes, oobleck, and even silly putty. We were a popular attraction inside the museum, with approximately 150 children and families coming through and looking at the ten stations of hands-on demos.

Courtney Fleming and Phurba Sherpa (president and secretary, SPS CU Denver) were in charge of presenting the Weissenberg effect. The demo was comprised of a rod attached to a motor that would spin in a non-Newtonian fluid consisting of long-chain polymers which we described as "spaghettilike." Common intuition would assume that the rod would simply stir the fluid, but the fluid actually begins to climb the rod instead. It was great sharing this counterintuitive result with the children. We explained the effect through an analogy of spinning a fork in spaghetti. They were all fascinated with the very long and thin strands of the fluid that could be formed with even the slightest contact. We described this with another noodle analogy where lifting one noodle would lift multiple if they were tangled. This was a great demonstration of how the microscopic structure of a fluid results in interesting macroscopic properties.

"I think teaching children to challenge their intuition at a young age will be very beneficial to their futures," Sherpa said later, "and it was a privilege to have been a part of it."

I was one of the members to go out into the museum proper to introduce the attending children to the physics demos. I took a cup full of multicolored saturated hydrogel crystals that the kids could hold and squish and play with. The kids' eyes just lit up. I remember how much I loved to play with slime and stuff as a kid; I even did an elementary school science fair project with the same hydrogel crystals that I was showing the kids. This is a great way to introduce the next generation to the wonders of the world around them, and it was great to be there to help them do it!

A big part of these demos was giving the children the opportunity to interact with the fluids directly using plasticware and wooden sticks. This highlighted the inquisitiveness of the children and challenged them to try and explain what they were seeing in the demos. The Society of Rheology had instruction sheets printed for all of these demos that included easy-to-understand explanations that were geared towards younger children; these demos should be in every SPS chapter's toolkit!

As the event wrapped up, we realized how much fun everyone had had. Sherpa said that not only did he think the kids enjoyed themselves, but he "definitely found [him]self having a blast finding different ways to play with the fluids, even when all the kids had left." Now that's a successful outreach event. //

TOP: An SPS volunteer at the Denver Children's Museum conducts a viscosity demonstration.

ABOVE: Keegan Karbach and other Metropolitan State University SPS members demonstrate why Rheology is cool (and gross!). Photos courtesy of Brad Conrad.

INTERESTED IN HOSTING YOUR OWN OUTREACH EVENT? CHECK OUT THE SPS LIBRARY OF DEMOS AT www.spsnational.org/programs/outreach/demonstrations.

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