the SPS Observer
Volume L, Issue 4
WINTER 2017

Sticking TOGETHER

INCLUSION AND DIVERSITY IN PHYSICS

+PHYSCON RECAP

the SPS Observer

Editor
Rachel Kaufman

Managing Editor
James Merrick

Contributing Editors
Kerry Kidwell-Slak
Kendra Redmond

Copy Editor
Cynthia Freeman

Art Director
Tracy Nolis-Schwab

Layout Designer
Michael Wernert

SPS President
DJ Wagner,
Grove City College

SPS Director
Brad R. Conrad

SOCIETY OF PHYSICS STUDENTS

1 Physics Ellipse
College Park, MD 20740

301.209.3007 (tel)
301.209.0839 (fax)
sps@aip.org
www.spsnational.org

Find SPS on:

TABLE OF CONTENTS

WINTER 2017 ▪ VOLUME L, ISSUE 4

FEATURES

Sticking Together: Inclusion and Diversity in Physics

PhysCon Recap

ON THE COVER
See "Sticking Together," on p. 20.

DEPARTMENTS

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

The American Institute of Physics is an organization of scientific societies in the physical sciences, representing scientists, engineers, and educators. AIP offers authoritative information, services, and expertise in physics education and student programs, science communication, government relations, career services for science and engineering professionals, statistical research in physics employment and education, industrial outreach, and the history of physics and allied fields. AIP publishes *Physics Today*, the most influential and closely followed magazine of the physics community, and is also home to the Society of Physics Students and the Niels Bohr Library and Archives. AIP owns AIP Publishing LLC, a scholarly publisher in the physical and related sciences.
www.aip.org

AIP American Institute of Physics

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

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

Sticking Together: The Value of Diversity and Inclusion in Physics

MESSAGE FROM THE SIGMA PI SIGMA PRESIDENT

by Willie Rockward, PhD, Morehouse College

Diversity and inclusion are to the physics and astronomy communities as letters and numbers are to communication. Physics, as a discipline, inherently values unique approaches and solutions, and this translates to its members. As a truly global group of professionals that spans many interests and fields of study, we must learn to accept one another for who we are and strive to form a society in the truest sense of the word to meet today's greatest challenges.

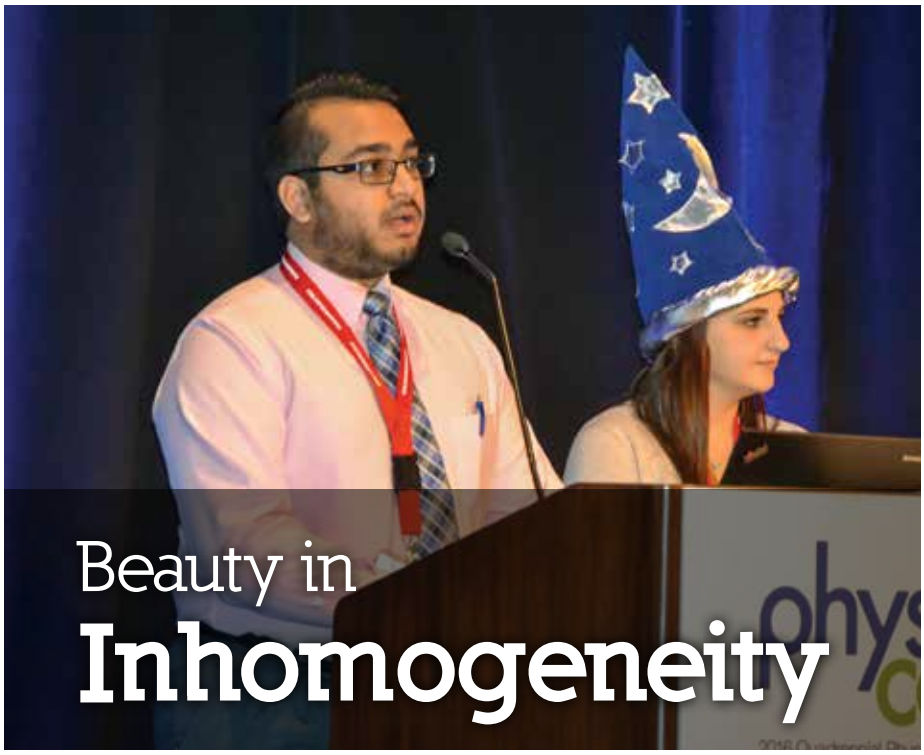
Like spherical cows, thinking that individuals working alone can change our understanding of the world overnight with a grand idea is an oversimplification. It takes all of us, working together, to solve problems. And, as these problems grow in size and scope, so must our teams and approaches. When we look back at major technological advances such as the laser, the Internet, and the cell phone, they required a diverse team of scientists and engineers of different backgrounds, thoughts, and resources. Quoting Dr. Donnell Walton of Corning Inc. (inducted into ΣΠΣ in 1986):

> "IN SCIENTIFIC RESEARCH WE ARE OFTEN CONFRONTED WITH SITUATIONS FOR WHICH SOLUTIONS AND ANALYTICAL POINTS ARE UNKNOWN. IT TAKES A TEAM AS DIVERSE AS POSSIBLE TO ENVISION ALL POSSIBLE APPROACHES, OUTCOMES, AND SOLUTIONS.
>
> It is through the interaction of different perspectives that true innovation emerges."

Thus, a team of researchers utilizing diversity, equity, and inclusion in their approach can have a higher probability of driving innovation.

This issue of *The SPS Observer* should challenge you to consider how you contribute to the diversity of our field and what you can do to better promote the inclusion of everyone. It's up to each of us to lead the scientific community (and society in general) toward positively valuing diversity and inclusion in all of our pursuits. There is a place for everyone in the physical sciences. The key to accomplishing this lofty, but necessary, goal is to engage with our peers, to make conscious efforts to promote the inclusion of all, and to support the mechanisms that bring us together. We elevate our discipline and the physical science community when we stick together. //

SIGMA PI SIGMA PRESIDENT Willie Rockward, PhD, Morehouse College. Photo courtesy of the American Institute of Physics.



Beauty in Inhomogeneity

AT PHYSCON 2016, Deval Mehta, associate zone councilor representative ('15-'16), and Sally Dagher, Zone 7 associate zone councilor, introduce Bill DeGraffenreid, PhD, (not pictured) and Brad Conrad, PhD, (not pictured) during the closing workshop. Photos courtesy of the American Institute of Physics.

by Deval Mehta, Former AZC Rep, Stony Brook University

We have a natural proclivity to declare something "beautiful" if it has some kind of inherent symmetry; if something about it is "the same" as something else, that is to say, if there exists some degree of homogeneity. In physics, we love symmetries because from them we glean insights about the world that otherwise may be difficult to ascertain. Despite the prevalence of symmetry and homogeneity in nature, not all things that are beautiful must exhibit these properties, especially the beautiful landscape of minds that comprises the Society of Physics Students.

During my time as a member of SPS, I've met many people, each of whom has walked a different path to reach their current point in life. Of course, all of them have had at least two things in common: a love of physics and the community around it, and a significant impact on me.

I remember stepping into an SPS meeting as a freshman at my alma mater, the University of Delaware, for the first time. It was amazing seeing people with a variety of experiences all in one room, enjoying each other's company. I experienced the same awe many times over: at the first meeting of every semester, during zone meetings, at National Council meetings, and of course, at the 2016 PhysCon.

At the 2016 PhysCon and over the course of the past year, I've had the distinct privilege of serving as your associate zone councilor representative. Holding a National Council position introduced me to a diverse and loving group of individuals—diverse not only by traditional metrics, but also representing diversity of thought, diversity of academic and career paths, and a diversity of approaches. I've met and walked alongside budding physicists as they proceeded on their journey. I've met established physicists who have provided me with an astounding amount of guidance. I've met individuals in an array of fields who, though not practicing physicists, are scientists at heart and have brought to light the countless possibilities that exist for those who love science. I cannot express enough how thankful I am to have been able to experience such an incredible adventure.

With the close of PhysCon on Sunday, November 6, my term has come to an end and a new chapter has begun, in which the Executive Committee now includes my good friend Nick DePorzio. Nick and I served together on the National Council last year and I was overjoyed to learn that he had been reelected. He is a fearless and ambitious leader who is not afraid to speak his mind. More importantly, Nick refuses to allow a single voice to be left unheard. I know that he will serve you well during his time as AZC Rep.

As we move forward, I know that this is not the last time I will experience such a breadth of loving and inclusive individuals. Our paths will cross again, so long as we are willing. Until I see you again, and even beyond that, continue to love yourself, to love others, and employ that love to move above and beyond. Embrace those with different perspectives and have a conversation. Don't just talk, but take time to listen. Allow me, as I embark, to welcome you to this new era of open communication. //

Concerned about the state of science?

Researchers are worried about their funding and the new US administration's science priorities. AIP has recently expanded the email bulletin *FYI* to keep scientists better informed. *FYI* will enable you to track funding trends and developments at all the government agencies involved with science.

Sign up for this free email service at AIP.org/FYI

AIP
American Institute of Physics

Seeking Unification: Advice for Promoting Diversity as a Department

by Austyn Long, SPS Member, NC State University

"WELCOME. PLEASE PREPARE AN ATTITUDE OF COMPASSION."

These are the words that greeted students of the NC State SPS and faculty in the department as they filed into a conference room chosen at the last minute, where the projector was still warming up. While the venue and mechanics seemed thrown together, these gears were set in motion a week prior by racist text messages posted to a student message board. In response to those messages, the gathered students and faculty created a 2-hour diversity and inclusion program, discussing racial inequalities and relations, responsible use of privilege, and ways to use their new knowledge to further equality.

The field of physics faces many challenges, but one of the greatest is our lack of diversity. The key to facing this issue lies in committing ourselves to building an inclusive environment. The prevailing opinions from the faculty I consulted were to create a safe space for open, honest communication. Rather than a title, the first slide of our guided discussion featured the text above as a reminder of this goal.

Our program, developed by Dr. Jamila Simpson, Dr. Karen Daniels, Dr. Sharonda LeBlanc, and myself, focused on racial **microaggressions** and white **privilege**, the injustices they create, and how they play into receiving a physics education. As it turns out, it's remarkably easy to earn a degree with no knowledge of the problems minorities face in obtaining the same degree.

When I approached professors with the idea that I wanted to replace our bi-

NC STATE UNIVERSITY

weekly meeting with a talk about racism, I felt much trepidation. Often, physicists meet the social sciences with disdain, and I worried an event focused on social relations would make me feel like I was pulling teeth. However, I underestimated the curiosity for which physicists are also famous. I was met with earnest questions and reassuring nods from the faculty who supported me in creating the event. People asked "how can I help?" and had a willingness to share personal experiences. I do recommend stressing the importance of creating a "what is my job" mindset rather than the "how can I help," which adds agency and erases the "helper-helpee" relationship and instead creates one of partnership. The support I encountered made it possible for us to host such an event.

We structured our event into three main sections:

- Definitions, Facts, and Figures, and their implications. We defined privilege, microaggressions, and institutional racism.
- Applying these concepts specifically to racism (although this could be tailored to chapters with specific problems in other areas).
- Activism and working to create justice, or "Allyship" and responsible use of privilege.

In each section, we allotted ample time for students and faculty to share their experiences. This, I feel, was most important to the success we saw. Because there was a safe environment where discussion was encouraged, my role became that of moderator rather than lecturer. I can only hope that students left feeling empowered to stand for change.

If you want to host a similar event at your campus, here is some advice:

- Keep the focus on education and empowerment.
- Use scholarly articles to develop and support discussion points.
- Allow people to share their experiences and feel safe doing so, so that discussion doesn't become defensive.
- Reach out to faculty to make this possible, and also to classrooms. This allows for the message to reach farther.
- Discuss with members of SPS how future events should be handled.
- Give students the language to describe the problems and educate others — empowering people is the best path to change.

We were motivated by events on campus, but it's my feeling that this kind of program is valuable in any physics department. In a field where so many members hold a lot of privilege, it's important to begin a culture where that privilege is leveraged in a way that advances equality. Education is the first step. //

Simplify your search. Visit **SPS Jobs** on your computer, tablet, or mobile device to browse jobs anytime, from anywhere!

http://jobs.spsnational.org

partner in the AIP Career Network

Understanding and Promoting Diversity and Inclusion in Physics

by Geraldine L. Cochran, PhD – Dean of the Douglass Project for Rutgers Women in Math, Science, & Engineering, Rutgers – The State University of New Jersey

Have you met someone who approached things differently than you and it seemed to perfectly complement the way you think? Maybe that person seemed to have the missing piece to the puzzle you were striving to solve. I can recall, as an undergraduate, staying up all night working on a problem in my mathematical methods course. I went to sleep dreaming about the problem, and when I woke up, I would make some headway but just could not seem to finish the problem. I was missing that last step. I discussed the problem with a friend who said she had difficulties with how to start the problem, but she was able to finish it easily. I now realize that it takes all types of people, from various backgrounds and perspectives, to solve the toughest problems. To some extent, I think we all value diversity in our lives, and it is important to bring the notion of diversity and inclusivity into all facets of the physics community, as well as within our everyday lives.

SO, WHAT IS DIVERSITY AND INCLUSION?

Though most understand the value and importance of diversity and inclusion, historical, political, and societal contexts have led to diversity being a challenge for individuals, fields, and institutions, particularly when it comes to certain aspects of diversity, such as race, ethnicity, gender, sexual orientation, socioeconomic status, religion, and ability. So, what is the difference between diversity and inclusion? Diversity is having a whole—an organization, an institution, a field—composed of parts that are different. Inclusion, though, is different than diversity. I often think of an inclusive environment as one in which members feel welcome, supported, and valued by the other members of the community. Namandje Bumpus takes it a step further, noting that, "Inclusion speaks to whether individuals have equal access to opportunities and empowerment."[1] An inclusive environment is certainly not one in which members feel isolated. It is not an environment where anyone is made to feel that their only contribution to the community is their race/ethnicity, gender, or sexual orientation—in other words, tokenization. Within the physics community, diversity and inclusion means attracting underrepresented communities to physics academia and careers, and making strides to ensure that various groups feel welcomed and accepted into our great community. Our physics community should be representative of our everyday community: diverse.

GERALDINE L. COCHRAN, PhD
Photo courtesy of Geraldine L. Cochran.

IS THE PHYSICS COMMUNITY DIVERSE?

In general, the physics community is not as diverse as we collectively would like; however, great strides have been made to improve our local environment. According to the Statistical Research Center of the American Institute of Physics (AIP), 20 percent of bachelor's degrees awarded in 2014 in physics went to women,[2] though women represented approximately 51 percent of the population.[3] This denotes the underrepresentation—one measure of diversity—of women in physics at the bachelor's degree level. African Americans earned just over 2 percent of physics and astronomy doctoral degrees and Hispanics between 3 and 4 percent in 2012, also denoting underrepresentation.[4] This underrepresentation in degree attainment naturally leads to underrepresentation in the workforce. The table at right illustrates the underrepresentation of ethnic/racial minorities among physics faculty.

More work to actively encourage diversity among the physics community at all levels needs to be accomplished. I would encourage reviewing reports produced by AIP's Statistical Research Center **(https://www.aip.org/statistics)** to understand what diversity and representation are like in the field of physics at various levels.

To illuminate the tremendous strides we've made towards a more diverse physics community, I've provided a few examples of fantastic physicists who have brought to light issues surrounding ethnic/racial minorities, gender equality, and LGBTQIA persons in physics. I am encouraged by the work of Jedidah Isler, the first African American woman to receive a PhD in astrophysics from Yale, to support women of color in a variety of scientific fields through Vanguard STEM,[5] the work of Jami Valentine, the first African American woman to receive a PhD in physics from Johns Hopkins University, who founded a website dedicated to African American women in physics, AAWiP,[6] the service of Chanda Prescod-Weinstein, who created and manages a virtual space for black women in physics and astronomy to build community and serve as resources for each other; the efforts of Ximena Cid, the first Native American (Yaqui) to graduate with a PhD in physics from UT Arlington, to support Latinx, Native, and other ethnic/racial minority students in physics through physics education research and leadership in physics professional societies; the work of Ramón Barthelemy, who utilizes his expertise in research design, statistical research, and physics education research to bring to light some of the challenges faced by women, ethnic/racial minorities, and LGBTQIA

persons in physics through evidence; and the leadership of Brittany Kamai, one of only five Native Hawaiians and the second Native Hawaiian woman to earn a PhD in physics, who serves as a mentor to diverse groups of students in astrophysics and has served on advisory boards to improve bridge programs for students. I am encouraged by the rise of bridge programs in physics designed to provide support to ethnic/racial minorities, women, and students from low-socioeconomic backgrounds to overcome economic, societal, and educational disadvantages that might otherwise serve as barriers to them obtaining graduate degrees in physics, while also working to make structural changes that might remove some of those barriers completely. Again, this list is not exhaustive, but it includes a few people who have recently encouraged and inspired me to be more active in my pursuit of making physics more diverse and more inclusive.

RACE AND ETHNICITY OF PHYSICS FACULTY	PHYSICS			ALL DISCIPLINES*
	2004 (%)	2008 (%)	2012 (%)	2009 (%)
AFRICAN-AMERICAN	2.0	2.2	2.1	6.6
ASIAN	10.6	13.2	14.3	6.0
HISPANIC	2.7	3.1	3.2	4.0
WHITE	82.2	80.0	79.2	74.9
OTHER	2.2	1.5	1.2	0.5

Data for all disciplines (which includes non-science disciplines) found at http://nces.ed.gov/fastfacts/display.asp?id=61

www.aip.org/statistics

IS THE PHYSICS COMMUNITY INCLUSIVE?

Inclusivity is a newer concept than diversity and, I believe, based on research and actions evidence gathered during discussions with physicists in a variety of settings, that there is still much work to be accomplished to make our community a holistically inclusive one. Many great physicists have already contributed to the body of work towards increasing inclusivity. If you are interested in learning more about gender discrimination and gender microaggressions (the everyday verbal, nonverbal, and environmental intentional or unintentional anecdotes that can communicate hostility and malice towards underrepresented populations), I encourage you to review the work of Barthelemy, McCormick, and Henderson[7] on gender discrimination in physics and astronomy, with a focus on sexism and gender microaggressions experienced by graduate students. Rosa and Mensah[8] also provide a great synthesis on black women physicists and overcoming obstacles in their pursuit of graduate degrees in physics. The review on gender in physics education research conducted by Traxler, Cid, Blue, and Barthelemy,[9] and other articles in the *Physics Review Physics Education Research* journal's Focused Collection on Gender in Physics, also provides an informative stance on gender in physics. I would also encourage a review of the LGBT Climate in Physics study published by the American Physical Society.[10] For more information on this study, reference the "Queer Physicists Speak Out" article on page 23. This is certainly not an exhaustive review of the literature, but rather some of the literature that I've recently reviewed that speaks to inclusion in the physics community. Though there is a lot of work to be done to create an inclusive environment within the field of physics across multiple levels (i.e., undergraduate, graduate), in multiple institutions (within academia and at national labs), and for persons with a variety of identities (i.e., ethnic/racial minorities, women, persons with disabilities, and LGBTQIA persons), I am not discouraged. In fact, I am encouraged because I find myself frustrated lately—not by the lack of opportunities to promote diversity and inclusion in physics, but rather by the time constraints that prevent me from taking advantage of the many opportunities to participate actively in these initiatives.

SO, WHAT CAN YOU DO?

I do hope that all of you will explore the work of those mentioned if you're not already familiar with it. Seek to get to know these amazing physicists and others, and you'll find yourself reinvigorated and more inspired to also actively work toward making physics diverse and inclusive at all levels and in all settings. Who better to take on the cause of increasing diversity in physics and creating an inclusive physics community other than physicists? I think most will agree with me that physicists are thought to be some of the greatest minds in the world, some of the best problem solvers. Naturally, then, physicists are well positioned to make physics a diverse and inclusive field. Albert Einstein, no doubt one of the most famous physicists, took a stand against racism and engaged in activism.[11] May we follow his leadership in enjoying the study and pursuit of physics while also working to make physics a diverse and inclusive environment. //

1. Bumpus, N. (2015). Moving toward inclusion. DOI: 10.1126/science.caredit.a1500273.
2. Mulvey, P. J., & Nicholson, S. (2012). Physics Bachelor's Degrees, *Focus On*. American Institute of Physics Statistical Research Center, College Park, MD.
3. US Census Bureau (2015).
4. Ivie, Anderson, & White (2014). African Americans & Hispanics Among Physics & Astronomy Faculty: Results from the 2012 Survey of Physics & Astronomy Degree-Granting Departments. American Institute of Physics Statistical Research Center, College Park, MD. (https://www.aip.org/sites/default/files/statistics/faculty/africanhisp-fac-pa-123.pdf)
5. http://vanguardstem.com/author/jedidah-isler-phd/.
6. Valentine, J. M., & Tucker, J. (2016). African American Women in Physics. http://www.aawip.com.
7. Barthelemy, R. S., McCormick, M., & Henderson, C. (2016). Gender discrimination in physics and astronomy: Graduate student experiences of sexism and gender microaggressions. *Physical Review Physics Education Research*, 12(2), 020119.
8. Rosa, K., & Mensah, F. M. (2016). Educational pathways of black women physicists: Stories of experiencing and overcoming obstacles in life. *Physical Review Physics Education Research*, 12(2), 020113.
9. Traxler, A. L., Cid, X. C., Blue, J., & Barthelemy, R. (2016). Enriching gender in physics education research: A binary past and a complex future. *Physical Review Physics Education Research*, 12(2), 020114.
10. Atherton, T. J., Barthelemy, R. S., Deconinck, W., Falk, M. L., Garmon, S., Long, E., Plisch, M., Simmons, E. H., & Reeves, K. (2016). LGBT Climate in Physics: Building an Inclusive Community. American Physical Society, College Park, MD.
11. Jerome, F., & Taylor, R. (2006). *Einstein on Race and Racism.* Rutgers University Press, New Brunswick, NJ.

Honoring the Life of Vera Rubin

by Brad R. Conrad, PhD, Director, Society of Physics Students & Sigma Pi Sigma

The Society of Physics Students and Sigma Pi Sigma Honor Society extend their deepest condolences to the family of Vera Rubin on her passing on Sunday, December 25, 2016. Vera was a lifelong friend to undergraduate physics and astronomy students and to SPS. She is best known for her discovery of evidence for dark matter through an inconsistency between how galaxies appear to rotate when observed from Earth and what Newton's law of gravity would predict. Her work has led to the modern theories of dark matter and modified Newtonian dynamics.

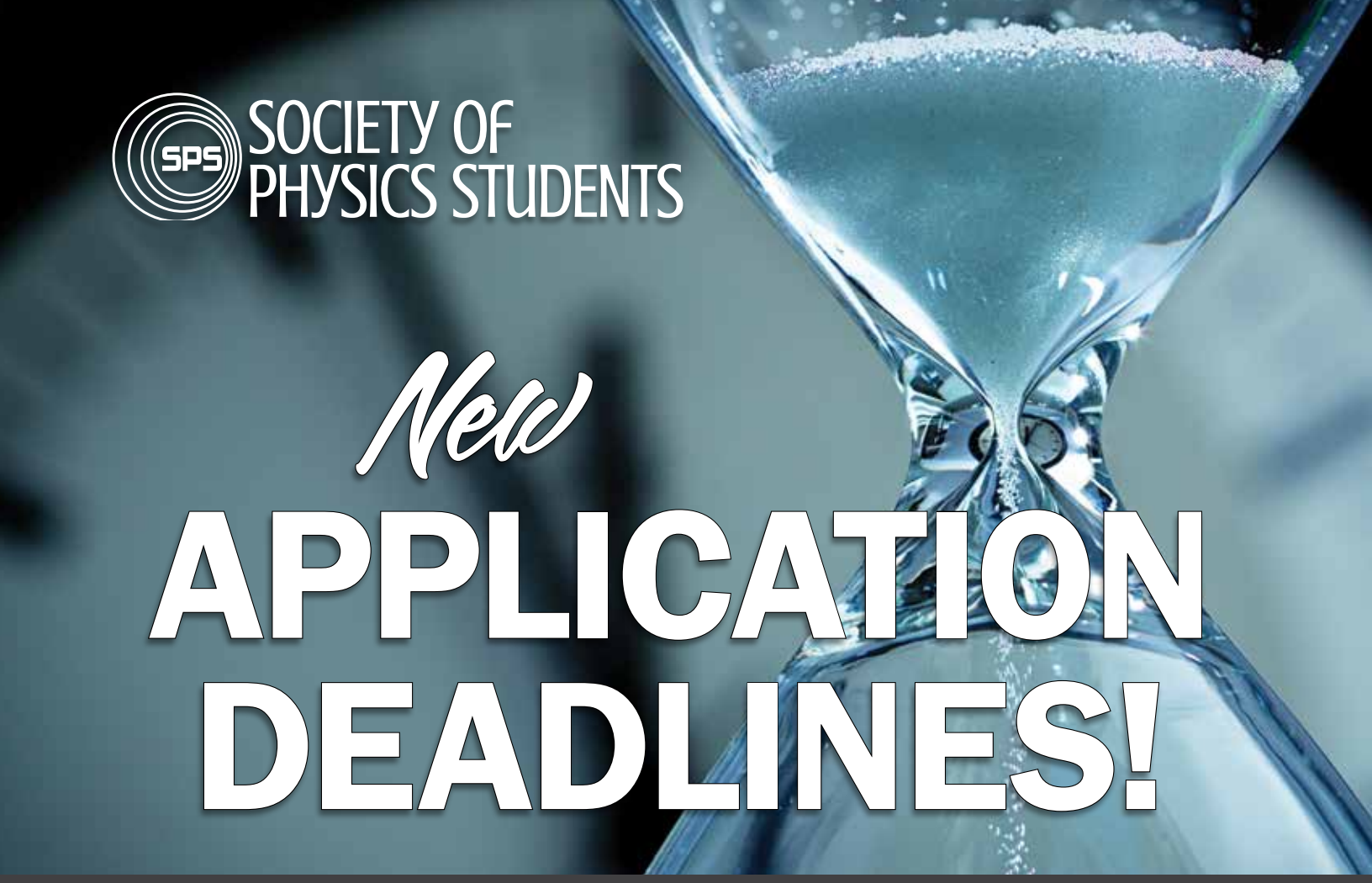
Among her numerous awards, Vera Rubin was inducted as an honorary Sigma Pi Sigma member in 2010 "for her masterful documentation of the stellar rotation curves of galaxies, with their profound implications for the sources of gravity in galaxies or gravity itself, her mentorship of women and men in science, her dedicated study of the history of women astronomers, and her generous spirit of support to undergraduate physicists and astronomers everywhere."

Rubin was not only a role model for many students and researchers alike, she was an advocate for women in science and sought any opportunity she could to share that passion with the next generation of scientists. In her own words to the National Academy of Sciences: "Fame is fleeting. My numbers mean more to me than my name. If astronomers are still using my data years from now, that's my greatest compliment." Her drive, wisdom, and love of discovery will be missed. //

TOP LEFT: On February 16, 2010, Sigma Pi Sigma recognized Dr. Rubin with its highest distinction: Honorary Membership.

LEFT: After speaking at an undergraduate research session in 2010, Dr. Rubin enjoys a meal and good fellowship with the SPS students in attendance. Photos courtesy of the American Institute of Physics.

ORAL HISTORY WITH VERA RUBIN AT AIP:
https://www.aip.org/history-programs/niels-bohr-library/oral-histories/33963



SOCIETY OF PHYSICS STUDENTS

New APPLICATION DEADLINES!

Mark your calendars!

The Society of Physics Students (SPS) and Sigma Pi Sigma have consolidated deadlines for awards, scholarships, and internships. There is now one deadline each season. These opportunities are available only to chapters and members, so remember to pay your dues to qualify.

FALL DEADLINE: November 15
- Sigma Pi Sigma Chapter Project Award
- Future Faces of Physics Award
- SPS Chapter Research Award
- Marsh W. White Award

WINTER DEADLINE: January 15
- SPS Internships

SPRING DEADLINE: March 15
- Outstanding Chapter Advisor Award
- SPS Award for Outstanding Undergraduate Research
- SPS Scholarships

SUMMER DEADLINE: June 15
- Chapter Reports
- Blake Lilly Prize

ONGOING OPPORTUNITIES:
- SPS Travel Awards
- SPS Reporter Awards
- SOCK Kit Requests

Learn more at

www.spsnational.org/awards

SPS National Office • Email: SPS-Programs@aip.org • Tel: 301-209-3007

aip.org

AIP American Institute of Physics

Chasing Rainbows

by Donald Simanek, Emeritus Professor of Physics, Lock Haven University of Pennsylvania

One St. Patrick's Day, thinking of leprechauns and pots of gold, this puzzle came to mind. In my search for challenging physics puzzles, I look for those that are relatively simple, and for those for which you won't find correct answers with a simple web search. Yet, with a little thought—and a little physics—the answer, when found, seems obvious.

Here's a question often seen on the web. Many answers found there are simplistic and unconvincing. Textbooks seldom raise the question.

HOW FAR AWAY IS A RAINBOW?

a. As far away as the cloud of water drops that forms the rainbow.
b. Just nearer than distant objects, such as mountains.
c. As far away as the horizon.
d. As far away as the sun.
e. At infinity.
f. Well beyond infinity.
g. There's no way to determine its distance.
h. As far away as you want it to be.

You need to know this before you set off to find that pot of gold at the end of the rainbow. Explain and justify your answer.

DISCUSSION AND ANSWER

On the web I've seen many different answers given to this question, defended with simplistic or insufficient arguments. My discussion of this is at odds with most of the answers found there.

First, how does one define "rainbow," "image," and "distance"? Is the rainbow an image in the sense the word is used in physical optics? Clearly there's a replica of the rainbow cast on the retinas of our eyes. The rainbow image can also be captured with a camera. Is the rainbow itself a real image? If so, what is it an image of? How does one measure distance to such an ethereal thing?

Some argue that no two people see the same rainbow, since they each see light coming from different collections of water drops. But suppose two people stand side by side and look at their image in a large mirror. Each sees light that was reflected from different places on the mirror surface, yet neither denies they are looking at the same image of themselves, and they agree on the details of it. That image is a virtual image, for the rays reaching our eyes arrive from directions that converge back to points behind the mirror where the image appears to be located. But there's nothing back there. Still, by extrapolating those rays behind the mirror, we can locate where the rays diverge from, and we can say with conviction, exactly where the image is located in space.

Let's dispose of the question "Is the rainbow an image of something?" Yes. It is an image of the sun. Images can be distorted, as are the images in a fun-house mirror. A rainbow is an image of the sun, smeared around a circular arc, and also radially smeared into colors by dispersion in the water drops. Since the rainbow has a definite geometric size and shape, we can legitimately ask where it is located.

We use stereoscopic (two-eyed) vision to judge the relative distance to objects. Unfortunately, rainbows are too far away for our visual stereoscopic judgment, since our eyes are separated only 2.5 inches. But we could use the same principle to triangulate the distance if we observe the rainbow from two positions sufficiently far apart. If we do this we are in for a surprise.

Of course rainbows require a cloud of water drops, and that cloud must be on the opposite side of the sky from the sun. This is not fundamentally different from the fact that a mirror must be located in front of you for you to see your image. If you go behind the mirror you will see no image. If you go beyond the water drop cloud you won't see the rainbow. Can we say that the image in a mirror is at the surface of the mirror? No. Just as the image in the mirror is behind the mirror, we will find that the rainbow is behind the water drops, i.e., at a greater distance from us.

To understand exactly how much greater, we'll delve into the math in the next issue of *SPS Observer.*

FIG. 1. A perfect rainbow. Dorset, UK. Photo ©Kris Dutson. http://www.southernscenicphotography.co.uk/

MORE INFORMATION.

- Rainbow stereoscopy. *Science Animations.*
- The mathematical physics of rainbows and glories. John A. Adam, *Physics Reports* 356 (2002) p. 229–365.
- All about rainbows, double rainbows, circular rainbows! *Skulls in the Stars.*
- Rainbows. *Hyperphysics.*
- Greenler, Robert. *Rainbows, Halos and Glories.* Cambridge Univ. Press, 1980.

CORRECTION.

An alert reader, Carl Reiff, noticed my answer to puzzle 2 in the Fall 2016 issue had a misprint in the last sentence. It should have read, "The barycenter is again important here. The earth is closer to the sun at full moon. At noon at full moon, the center of the earth is 2×4671 = 9342 km closer to the sun than it is at noon at new moon. So you are also that much closer to the sun at noon at the time of *full* moon." //

Feedback is appreciated from readers. E-mail dsimanek@lhup.edu. If you have a favorite physics puzzle that is not well known, not easily found on the web, or in the many published physics problem books, send it along. Include your answer, too, if you have one. If used, we'll credit you. I especially like puzzles that can be solved with insightful and simple arguments, preferably with minimal mathematics.

For other examples of these concepts, check out:

2013 SCIENCE OUTREACH CATALYST KIT – "Sensors, Detectors, and Meters – Oh My!" : https://www.spsnational.org/programs/outreach/science-outreach-catalyst-kits/2013/sensors-detectors-and-meters-oh-my

2014 SCIENCE OUTREACH CATALYST KIT – "Light: A Spectrum of Utility" : https://www.spsnational.org/programs/outreach/science-outreach-catalyst-kits/2014/light-spectrum-utility

A Physicist's Best Friend: Fermi Questions

HOW MANY PIANO TUNERS ARE IN CHICAGO?

by Brad R. Conrad, PhD, Director, Society of Physics Students & Sigma Pi Sigma

Enrico Fermi would famously ask his introductory course students to answer that question, without aid of book (or İnternet). This seemingly impossible task can be accomplished in several different ways, with only background knowledge. The results, while not precise, should be excellent estimates, provide the scale of the correct values, and agree with the actual solution within at least an order of magnitude.

Of course, it isn't important to know exactly how many piano tuners there are in a city. You can simply look it up! What is important is to be able to estimate an unknowable quantity quickly and logically. The real goal is to know, "About how many?" to get a sense of what we might expect if we could look up the answer: Is it two? Ten? Five hundred? Ten thousand?

Physics is a wonderfully messy science, full of these back-of-the-envelope questions. We often seek to see if something is even possible or, roughly, how big are we talking? Is the electric field strong enough? How much current do we need? Could we even reach that temperature? What value do I even expect? Through the use of logic, estimation, and reasonable assumptions, we can often determine a quantity to within an order of magnitude, or if we are good, maybe even a factor of 2, with just a pen and something to write on.

"Back-of-the-envelope" calculations are often a physicist's first line of attack against the unknown. They are so important that they are commonly asked in technical interviews because the process of generating a solution is an excellent, on-your-feet test of reason and intellectual skill.

LET'S GIVE IT A TRY: COFFEE CONSUMPTION

Here is an example near and dear to my heart: Many physicists are known to drink a lot of coffee. If we could brew coffee in swimming pools, how many pools would we need to satisfy the need in the U.S. on a given day?

SOLUTION:

Nobody knows the "real" answer to this question because no one would ever brew coffee in swimming pools! Below is one solution I came up with, but keep in mind there are many other ways of arriving at an answer, and not all solutions are equally good.

First, we must answer the following question: What do I need to know to answer this? This is not always easy, but I could answer this question if I knew both:

a) how much coffee people drink (as a volume) in the U.S. on a given day,
b) the volume of a swimming pool.

If I divide those two answers, I have my solution. Let's tackle (a) first:

I know there are roughly 350 million people in the U.S. Let's assume kids don't drink much coffee, so we ignore 20 percent of the population. Let's also guess that half of U.S. adults don't drink coffee at all. These are my assumptions, and I state them *explicitly* so that I can go back and change them later if I need to. And, even though we are talking about adults who drink coffee, each person drinks a different amount on a daily basis. Therefore, let's assume that on average everyone has 3 coffee drinks a day. That leaves us with:

$$3.5 \times 10^8 \text{ people} \cdot 0.80 \cdot {}^1/_2 \cdot 3 \ \frac{\textit{coffees}}{\textit{day} \cdot \textit{person}} = 4.2 \times 10^8 \text{ coffees a day}$$

Now, I assume a coffee is a standard U.S. cup of coffee, and I know that a cup is 8 oz, but the solution will be easier to deal with if we are working with metric units. Let's estimate that it takes 4 cups of liquid to fill a liter bottle. So, for my back-of-the-envelope calculation, 4 cups coffee is ~1 L of water. Notice that this is what I could do without any references handy so you might have a cleaner way of doing it.

We are thus dealing with: 1.05×10^8 L of coffee. And for pure water at room temperature, I know that 1 L of water is 10^3 cm^3 or 10^{-3} m^3. We thus have about 10^5 m^3 of coffee.

Now, let's tackle (b), how much water is in a swimming pool. I honestly have very little concept about how large a swimming pool is but I do know the standard pool is an Olympic swimming pool. I'd guess it to be 10 m wide, 25 m long, and 4 m deep. That would be a volume of:

$10 \text{ m} \cdot 25 \text{ m} \cdot 4 \text{ m} = 1 \times 10^3 \text{ m}^3$ for an Olympic swimming pool

And, dividing these two quantities we arrive at:

$$\frac{1 \times 10^5 \text{ m}^3}{1 \times 10^3 \text{ m}^3} = 1 \times 10^2$$

or approximately 100 Olympic-sized swimming pools of coffee.

While this doesn't tell us exactly how many swimming pools we'd need, it really doesn't matter if we are a couple off. We wanted to know about how many we'd need, just like we wanted to know about how many piano tuners we have in Chicago. Keep in mind that my answer is only as good as my assumptions, but we should expect the order of magnitude to be about right. And if I am good, I got us to within a factor of 2: somewhere between 50 and 200 swimming pools full of coffee.

These back-of-the-envelope calculations can help you simplify very complex systems to basic principles and help you come up with an estimate of what one might expect. Personally, I've been asked to do these kinds of questions in many job interviews, my thesis defenses, and even during talks I've given.

YOUR TURN!

This example is left as an exercise to the reader:

How many cats are sleeping in the United States right now?

Submit your answer to sps-programs@aip.org with the subject line, "Sleeping Cats." //

Creating a Creator:

Using a 3D Printer to Build a 3D Printer from Scratch

by Ryan Bouricius, SPS Member, Ithaca College

What started with a single machine in the back of Ithaca College Professor Michael "Bodhi" Rogers' geophysical archaeology laboratory has grown into a full-fledged 3D Laboratory with fifteen 3D printers and several 3D scanners. The lab has served to raise awareness for the wide range of creative applications using such technology in industries like healthcare, robotics, automotive, and national defense. In the midst of the growth in 3D technologies at Ithaca College, our SPS chapter received an SPS Chapter Research Award to 3D print a 3D printer.

Many of the pieces required to build a 3D printer are often made from plastic, so there is no reason that these pieces cannot be 3D printed themselves. The Prusa i3 open-source 3D printer is a great example of this idea. There are schematics online for printing several structural components of the Prusa i3 as well as parts lists for non-printed components. Everything that is not 3D printed is standard hardware or electronic components, such as stepper motors and steel rods.

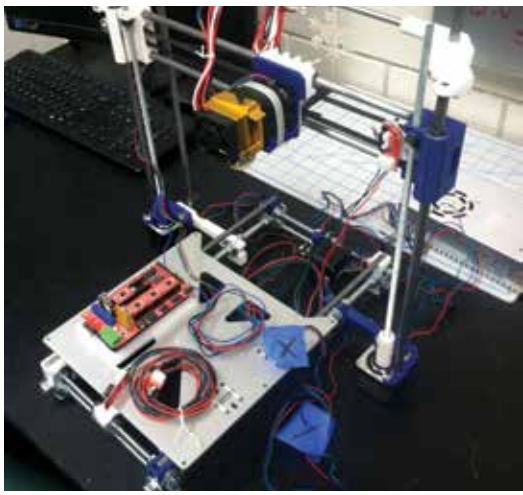
The project began with our team downloading the stereolithography files for all of the 3D-printed pieces. We used these files to print the structural pieces to hold the steel rod frame together, belt holders to move the tool head along each axis, and other components. We printed these pieces and purchased the standard hardware and electronic components. We assembled the printer and studied the purpose of each piece along the way.

People all over the world have printed versions of the Prusa i3. Despite small differences in size and layout, many of these printers are effectively the same. Our club is now developing ideas for modified 3D printers. Like the Prusa i3, these printers would still print through a process called fused-deposition modeling (FDM), but they would feature new characteristics and efficiencies.

Additionally, we have been focusing on how to 3D print more of the necessary components. For example, most designs call for high-precision metal linear bearings, allowing entire assemblies to move together along perpendicular steel rods. These are more durable and reliable than their printed counterparts would be, however the printed set would be dramatically cheaper to manufacture and could be produced and modified onsite. A cost/benefit analysis will be a feature of our research as we use this printer for future projects.

When it is completed, the new printer will be used for outreach activities, class projects, and club fundraising events. It will make a unique addition to the existing fleet of printers.

Students involved in this project have gained valuable experience working with the world of 3D design. Seeing how the various aspects of the printer work together—mechanical, electrical, and digital—will help students with futures in research laboratories and STEM industries in the years to come. //



TOP: Some of the custom-printed components of the 3D printer.

BOTTOM: The 3D printer takes shape. Photos by Ryan Bouricius.

GET UP TO $2,000 FOR SPS CHAPTER RESEARCH!

For details, visit the SPS website at www.spsnational.org/awards/chapter-research.

Sharing Science

HIGH POINT SPS CHAPTER BRINGS THE UNIVERSE TO THEIR COMMUNITY

by Alan Vasquez Soto, SPS Vice President, High Point University

My freshman year at High Point University (HPU) I volunteered to build a hovercraft for an outreach station at a new SPS event, HPUniverse Day. The hovercraft turned out well, and the next year we built three of even higher quality. I love seeing the excitement as kids realize they can push their parents down the hallway with the touch of a finger.

This fall we hosted the third annual HPUniverse Day. About 1,200 people attended our 3-hour evening event. In three short years, we've significantly grown our event and successfully used it as a tool for engaging undergraduates in science communication.

At PhysCon this fall, one of the workshops focused on meeting students from other chapters and sharing how our chapters excel. I was shocked that when I mentioned that High Point communicates science well, no students from other chapters at my table thought this was common.

HPUniverse Day has pushed us to communicate science to a diverse crowd. Entertaining and inspiring kids to do science is the ultimate goal. Strong communication skills are key, or we risk boring everyone!

This year I helped faculty member Brad Barlow organize the event. It was very rewarding to see all of the work come together. The kids were very excited about all of the things that we did for them and really enjoyed the event. Next year I will take on more of the planning and another SPS student will help too. That way we can have another student organizer ready to take over after I graduate.

In the three years we've hosted this event, I've seen both new and returning attendees, which tells me that we're doing a pretty good job. Working at an outreach station may not seem like a big deal, but learning how a hovercraft works might be all a kid needs to become interested in doing science. Seeing their faces light up with a passion for pursuing something new and exciting is the reason we host HPUniverse Day. //

LEFT: SPS students Michael Beale (purple shirt) and Noah Novembre (white shirt) inspire visitors with a hovercraft.

BELOW: Volunteer Jonah Winkler helps attendees launch water bottles. Photos courtesy of High Point University.

THE LAUNCHING STATION

One of the most popular stops at HPUniverse Day is the water bottle rocket launching station. The kids pump up a restrained half-filled water bottle, increasing the pressure. Then the station leader releases the restraining mechanism and the bottle flies off, expelling water. With less than $50 of materials we've been able to entertain kids at every HPUniverse Day without having to do much more than apply duct tape. This activity is a great way of introducing kids to rocket mechanics. It teaches them how pressure imbalance gives you thrust via the expulsion of water. The water bottle rocket launching station has brought back some of the same kids from year to year. It was so popular this year, the line was 50–60 people long for most of the day. Online tutorials are available to help you aspiring rocketeers build one and incorporate it into your own chapter activities.

Feature

STICKING TOGETHER:

Inclusion and Diversity in Physics

BY SPS NATIONAL STAFF

"Diversity and inclusion" are ideas that most people agree sound nice but few know how to actually make happen.

By that, we mean it's rare to find someone who says diversity is *bad*, but it's easy to find good-intentioned students, faculty, and staff who *want* a more diverse, inclusive environment and yet aren't taking steps to facilitate it.

And here's the thing: just wanting "diversity" isn't going to result in a more inclusive environment in your department or chapter. You do have to work for it. All of us, together—students (especially SPS members), teachers, and school administrators—need to collaborate. It's not enough to just *say* we want diversity. We need to intentionally invite women and minorities into our chapter meetings and leadership, to end anti-LGBTQ policies on our campuses, and to ensure that people with physical and intellectual disabilities are accommodated and included.

In the following pages, you'll read about a number of diversity-related issues in the physics community. There are stories about programs intended to increase participation in STEM fields by minority populations, actionable takeaways that you can implement on your campus or in your chapter to make it more welcoming, and reflections from trailblazers who are doing the hard work of making change.

Let's not kid ourselves. The physics community is not perfect and, like many communities, has a long way to go when it comes to inclusion. Among the many STEM fields, physics has some of the lowest rates of awarding degrees to people of African American, Latino/a, or Native American descent, with less than 10 percent of bachelor's degrees going to those groups. Less than 5 percent of physics faculty belong to one of these underrepresented groups. LGBT physics students and faculty report being harassed because of their identity, and many women still wonder if they belong in a field so dominated by men.

We can do better, not only because it's "the right thing to do," but because physics is a better science when it understands and appreciates diverse viewpoints. If we want the best science, we can't afford to exclude anyone.

Here's toward a more diverse and inclusive community.

◀ *We are all made of starstuff*

by Jordan Rice, SPS Member, Carthage College

In this piece, I wanted to bring together science and art in a way that symbolizes the Earth's place in the universe. I believe that all humans recognize that the Earth is but a small piece in a much larger universe, but need to be reminded of exactly where we are and where we come from. By bringing together multiple aspects of art (painting and photography), I wanted to convey this idea through powerful imagery.

The art to the left was awarded first place in the "Unifying Fields" (mixed media) category in Sigma Pi Sigma's PhysCon 2016 Art Contest.

PRIVILEGE AND PRATFALLS:

The Role of an Ally in Physics

Adapted from a talk at the 2016 Summer Meeting of the American Association of Physics Teachers

BY SCOTT FRANKLIN

Professor, School of Physics & Astronomy, Director, Center for Advancing STEM Teaching, Learning & Evaluation, Rochester Institute of Technology

Scott Franklin, making a perfect cup of coffee. Photo courtesy of Scott Franklin.

Taking the time to truly listen to our students, classmates, and colleagues increases our ability to communicate and brings us closer together as a community.

One of the most exciting developments in physics is the growing awareness of the need to make our discipline accessible and inclusive to all. And it's more than just awareness: the field is making real progress towards inclusivity, too. Just last year, the American Physical Society commissioned a survey to study the work climate for LGBT physicists, a step that would have been unheard of when I was in college. For more information on this study, reference the "Queer Physicists Speak Out" article on page 23. APS also hosts numerous annual Conferences for Undergraduate Women in Physics and has standing and ad-hoc committees for women, minorities, and LGBTQ+ members. Incoming students are more comfortable in diverse environments, and are taking an active role in demanding equity for all.

The growing diversity in physics presents new challenges: cultures and practices developed within a homogenous culture may no longer work. Together we face the challenges of not only exploring new frontiers in physics, but also supporting our friends and colleagues by being allies in the fight for equality.

Many of us know that being

an ally is important but don't know where to start. That's why a number of us physicists are developing an approach that starts with three principles:

1. **Authentic help means everyone wins.**
2. **Personal experiences trump intellectual theory.**
3. **Building relationships and trust on the individual level makes a difference.**

The first principle was best articulated by Paulo Freire, a Brazilian advocate of critical pedagogy, who writes: "Authentic help means that all who are involved help each other mutually, growing together in the common effort to understand the reality which they seek to transform."

This means that equity can't be framed as someone in power "helping" (but actually dominating) a less privileged person. It turns out that those in power have as much to gain from equity as those marginalized.

In physics, this plays out in many ways. For example, data I've analyzed shows that of physics majors who pass at least one upper-level physics course, one in six then leave the major to graduate in another program. Clearly we are not retaining the "best and the brightest." If we did a better job of retaining marginalized community members in physics, our whole field would benefit.

The second principle is about data and how it can sometimes lead us astray. Physics likes to perceive itself as objective. While this may be an advantage in the lab, its blanket application to culture may further alienate those not in the majority. Here, perception trumps intent. Behaviors that seem natural—to faculty teaching class, students interacting in study groups, or researchers in labs—are perceived by individuals in different ways. For example, faculty often engage with students by asking them questions. That seems natural, but to some students this mode of dialogue is threatening. If they don't know the answer, they feel stupid and begin to think the professor is picking on them.

Similarly, we often interpret silence as consensus; the critical theorist Dr. bell hooks points out that it is "the absence of a feeling of safety [that] often promotes prolonged silence or lack of engagement." Taking the time to truly listen to our students, classmates, and colleagues increases our ability to communicate and brings us closer together as a community.

> ***Together we face the challenges of not only exploring new frontiers in physics, but also supporting our friends and colleagues by being allies in the fight for equality.***

These lead to the third principle—to act on an individual level. Here are some simple ideas that students can use: First, if you lead or help lead a study group or SPS chapter meeting, keep track of how long different gender/racial groups are speaking and check for equity in participation. Online tools (e.g., arementalkingtoomuch.com) make it easy to measure the fraction of a discussion claimed by (as presenting) men and women (and are easily modified to account for race, rank, or other characteristics).

My students have started using this when they work together in labs or activity-based classes, and the resulting discussions are more collaborative and productive. Now they brag about when their numbers indicate equitable participation, whether across gender or other lines, and informally compete to see which group can be most equitable.

Second, practice active "amplification." In September 2016, it was revealed that female White House staffers had adopted a practice of repeating key points made by women and giving explicit credit to the original speaker. This forced the men in the room to recognize the contribution (and denied them the opportunity to claim it as their own!). Even if you don't work in the White House, you can practice amplification. I do! Now, I see each meeting or discussion as an opportunity to amplify the voice of another. This requires much more active listening; I'm much less able to zone out or check e-mail, instead listening carefully to points raised by those in the minority. In workshop classrooms, we frequently assign students "roles" to play in their investigation. In addition to traditional "scribe" and "skeptic" roles, I have now introduced the "parrot," whose role it is to repeat with attribution any good idea that they hear.

I can't paint an overly rosy a picture. While the number of bachelor's degrees awarded in physics rose 58 percent between 2003 and 2013, the fraction awarded to women (20 percent) and African Americans (2 percent) was largely unchanged, and the numbers for those with intersecting identities (e.g., women of color) are even worse. And yet, the attitudes, energy, and awareness of the next generation give me hope that my son's experiences as a physicist will be much different and diverse than mine, and include more active discussions about ways to make physics a discipline in which all can truly participate. //

QUEER PHYSICISTS Speak Out

BY RACHEL KAUFMAN
Contributing Writer

In 2009, Elena Long attended her first conference as a physics grad student. Long, who is transgender, raised her hand in a Q&A session for women in physics, asking where the resources were for people like her—physicists who were LGBT. "I naively thought they were out there somewhere," she says. "After asking that, the whole room fell silent. And then somebody piped up, saying, 'Uh, we never thought of that.'

"Which was a little bit devastating at the time," she says. But after the session, people came up to her to start sharing, not published resources but names of allies who could help. That led to a listserv and website **(http://lgbtphysicists.org)**, which led to a roundtable, which led to a session at the APS March Meeting at which APS CEO Kate Kirby sat in the front row. And *that* led to the APS LGBT Climate in Physics report, the first of its kind, published in March 2016.

Dr. Long installing the solenoid for the University of New Hampshire's new DNP polarizer. Photo Courtesy of University of New Hampshire.

The survey underpinning the report reached over 300 physicists who identified as belonging to a gender or sexual minority. The results? Not surprising to the survey leaders. "A lot of the data is depressing but not entirely surprising, " Long says. Transgender people were misgendered by their colleagues frequently (40 percent of the time); more than one in five (22 percent) of respondents reported experiencing exclusionary behavior; and over a third (36 percent) considered leaving their institutions, a consideration strongly correlated with an uncomfortable workplace climate and the observation of exclusionary behavior.

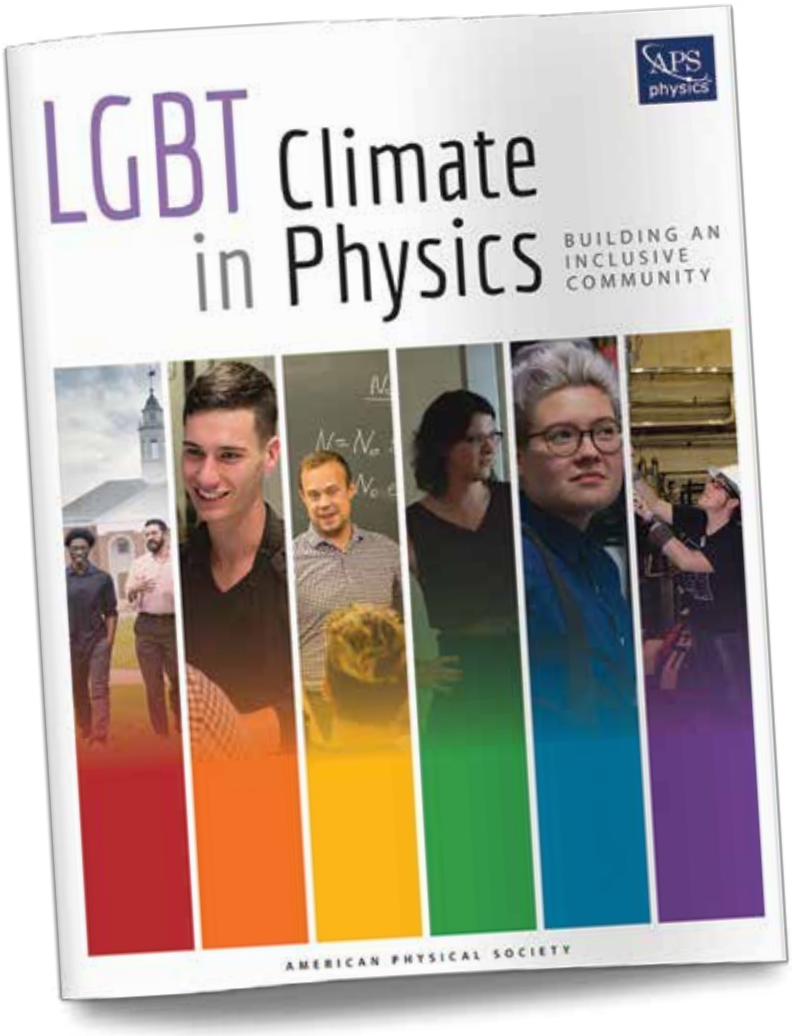
In fact, "observation of harassment was a stronger predictor of someone considering leaving their department, workplace, or major than

experience of harassment," says Ramón Barthelemy, APS/AIP sponsored AAAS Science and Technology Policy Fellow and a coauthor of the report. "When people are being harassed and it's seen, it affects everyone around them. From a policy standpoint, that's sort of a crucial thing to know. Harassment doesn't affect just the percent of people that say they are being harassed actively, but just observing has an impact."

That's a huge problem for physics departments that want to hire and retain the best professors and students. If simply seeing someone else experience harassment is enough to drive away talented people, then physics departments, professors, and SPS chapters have even more motivation to make everyone feel welcome.

I want there to be more LGBT physicists, and I don't want young people to look at this career and find people telling them to never be themselves at their job.

The importance of having this data can't be overstated. "Particularly for trying to get buy-in from other physicists who want to become allies, a number of [people] have said, 'There's no data on the issue, so obviously there's no problem,'" Long says. The new survey belies that claim.



The report itself was also a bit incendiary, just for reporting the results, Barthelemy says. "We received tons of harassment when the report came out. But we turned that around and said 'Look, this is what happened.' A lot of physicists who had said [discrimination] isn't a problem, [then] said, 'I just never knew.' It's my feeling and hope that most people…just needed the data to turn them. True physicists will listen to data."

So the data show that harassment of LGBT physicists is, in fact, a problem. So what do we do, as a community, about it?

Luckily, another effort spearheaded by the same group of LGBT physicists is available to help: the Best Practices guide, a free document showing physicists what they can do today, tomorrow, and over the long term to make an LGBT-friendly climate. The Best Practices guide can be found at: **http://lgbtphysicists.org/files/BestPracticesGuide.pdf**. Sample "today" ideas include using gender-neutral language, like "bring your spouse or partner" rather than "bring your wife," paying attention to climate in classrooms, and adopting a policy barring offensive language. Longer-term suggestions include lobbying for adding "sexual orientation" and "gender expression or gender identity" to the university's nondiscrimination policy and creating a trans-friendly bathroom policy.

This guide "has been the most important thing we've done," Long, now a postdoctoral research associate at the University of New Hampshire, says.

Through it all, most (but not all) of the work putting together resources and guides for departments that want to be LGBT friendly has been done by members of the LGBT physics community itself. "It's definitely been a massive amount of work," Long says. "It would have been nice to just have [these resources] and not have to do it all, but…I chose to step up to survive in the field—and I just wanted to know I wasn't the only one.

"I want there to be more LGBT physicists, and I don't want young people to look at this career and find people telling them to never be themselves at their job. I don't want anyone else to have to go through what I did," she says.

Honored in late 2016 as one of "Nature's 10: Ten people who mattered this year" for this work, Long says, "It's one of the best things I've ever done, because it means that the next generation of LGBT physicists is not going to be as isolated as all of us have been." //

The APS *LGBT Climate in Physics* report can be downloaded at www.aps.org/programs/lgbt/. Image courtesy of the American Physical Society.

A Conversation with Marcia McNutt

BY RACHEL KAUFMAN

Contributing Writer

Marcia McNutt. Photo courtesy of Marcia McNutt.

Women tend to thrive in climates where they are rewarded when they can work collaboratively; it's not hypercompetitive.

Geophysicist Marcia McNutt knows a thing or two about women in science. Throughout her career, she's taken the top job at organizations that had typically hired men for the job: she was the first female president and CEO of the Monterey Bay Research Institute, the first female director of the US Geological Survey (USGS), the first female editor of *Science*, and, as of last year, the first female president of the National Academy of Sciences (NAS).

In an interview with her former colleagues at *Science* in 2016, she said she sees her job at NAS as improving reproducibility and ethics, guiding the public's understanding of science, and promoting women in science.[1] To hear more about that last point, *Observer* sat down with McNutt to learn what barriers women face in science—and physics—and how we can overcome them. —*Rachel Kaufman*

DID YOU EVER FEEL LIKE THERE WERE THINGS WOMEN COULDN'T DO?

I never felt that. I think that the fact that I went to an all-girls school made

a difference. It wasn't until I got to college that I encountered the first sexist comment in my life. And by then I was 18, so my reaction was, well, what's wrong with you?

YOU'VE SHATTERED MULTIPLE GLASS CEILINGS IN YOUR LIFE. WHAT'S YOUR REACTION TO THIS?

[I have] sort of a mixed view. Take the USGS. When I got to the USGS, there were so many capable women in other leadership roles there that I guess my reaction was, "Well gosh, isn't it long past time for a woman to be in the top job here?"

THE PERCENTAGE OF BACHELOR'S DEGREES EARNED BY WOMEN IN STEM, AND IN PHYSICS SPECIFICALLY, HAS FLATTENED OUT OVER THE PAST DECADE. WHAT DO WE DO ABOUT THIS?

We don't have this problem in biology, we don't seem to have this problem in chemistry. Women are overrepresented in biology [at the undergraduate level]. The fact that this is an issue in physics. . . . It's important that they compare themselves to the fields that don't have the problem. Is it a problem with the climate? What is it that they aren't doing to attract women? Women tend to thrive in climates where they are rewarded when they can work collaboratively; it's not hypercompetitive.

WHAT CAN PEOPLE DO IN THEIR OWN WORKPLACES AND SCHOOLS TO HELP WOMEN SUCCEED?

I'm a strong proponent of informal mentoring and networking. I think it's really important. I've visited so many colleges and universities where I've seen women with virtually no to little resources do wonderful things just by helping each other.

When I was at MIT, we started a sort of brown-bag lunch discussion group because we had a large number of female graduate students in the geosciences and we felt that the female grad students were thinking too narrowly about career paths. Students looked at the women on the faculty and felt that female graduates should be thinking about going into academia, whereas our discussion group felt there were many things female graduates could do—they could go into industry or government. We invited back graduates from MIT to talk to the current students about what they liked about their jobs. We advertised this for women students, but the men came too.

Women are doing more of the advising, more of the mentoring, more of the committee work, and they tend not to get credit for it.

WHAT ARE LARGER PRO-WOMEN POLICY CHANGES PEOPLE SHOULD PUSH FOR AT THEIR WORKPLACES?

I've written editorials[2] about how I think tenure is the most female-unfriendly policy we have. Tenure comes at the same time as the biological clock is ticking.

I think we need to rethink how we evaluate faculty constantly throughout their career for how they are contributing in many ways to the university.

Any time you change anything in the oldest institutions, save the Vatican, in which the people who are a part of it still walk around in medieval robes, obviously it's going to be very difficult to do.

AS PRESIDENT OF NAS, WHAT ISSUES AROUND WOMEN IN SCIENCE WILL YOU BE CHAMPIONING?

Obviously I would like to increase the proportion of women who are in the Academy. That's one thing we can clearly do.

[We also want to] look at the additional burdens that women carry within the university and other workplaces. Women are doing more of the advising, more of the mentoring, more of the committee work, and they tend not to get credit for it. So one thing we need to do is figure out how to balance the load, or give women credit for the extra work they are doing.

[I'd like to see] exit surveys when women [undergraduates] change fields. It'd be interesting to know why women switch from a physics major to pursue something else. Because if it actually is the climate in physics, it would be good to know that. If it is instead a perception of the job market, then you would expect equal amounts of men and women to leave. Unless women are smarter than men and notice [the job market] more. And I could believe that. //

1. http://www.sciencemag.org/news/2016/07/science-academys-new-president-cleared-many-hurdles-way-top
2. http://science.sciencemag.org/content/350/6266/1295.full

How Can You Help?

Robin Ely, a professor at Harvard Business School, told the online publication *Mashable*[1] that the stereotype of the "queen bee" woman at the top is incorrect; most women do want to help other women.

Here are a few ways women at all levels, whether students, faculty members, or working professionals, can help.

TRY AMPLIFICATION

This technique made headlines last fall when female White House staffers revealed they'd been employing this strategy: when a woman made an important point in a meeting, another woman would repeat it, loudly, giving credit to the originator. They came up with this technique after noticing that women in meetings were being talked over or their ideas were being appropriated by men.

WATCH YOUR IMPLICIT BIAS

Everyone—men and women—can fall prey to implicit bias. If you find yourself responding negatively to a woman, ask yourself if you'd feel the same way if the person was a man. As a first step, try taking an Implicit Association Test at Harvard's Project Implicit; it takes about five minutes and can show that many people hold biases they don't even know to be there. https://implicit.harvard.edu/implicit/takeatest.html

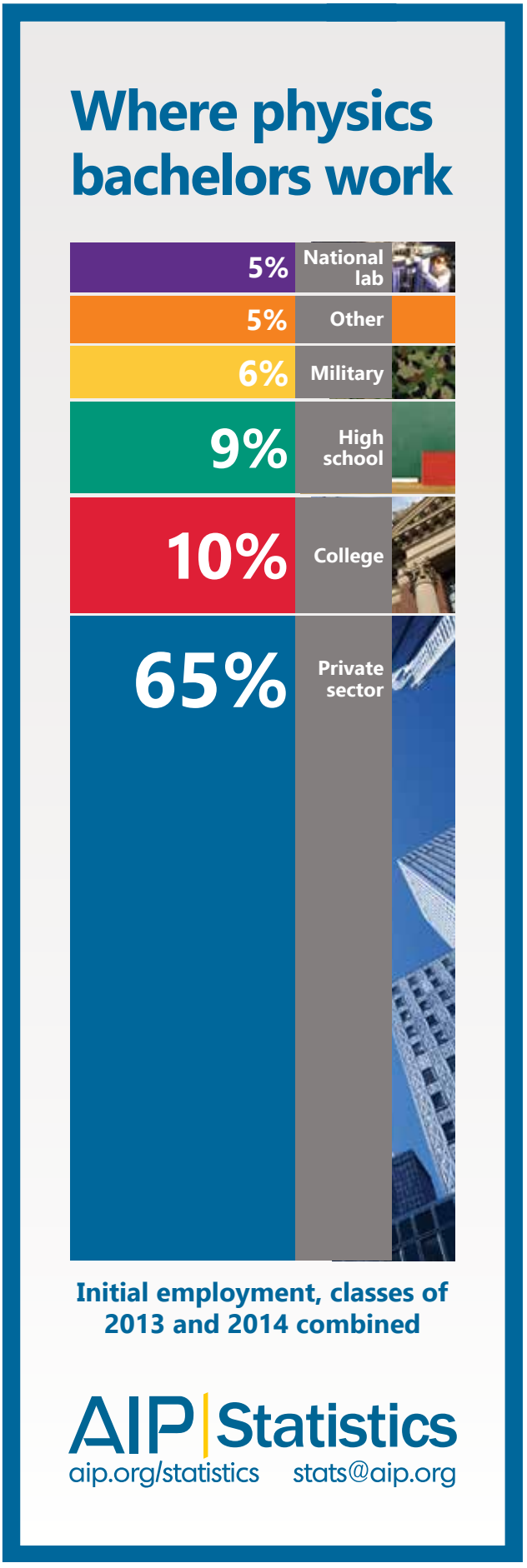
DON'T WORRY TOO MUCH ABOUT "LEANING IN."

Arianna Huffington told Sheryl Sandberg[2] —who coined the phrase "lean in" in 2013—that she endorses a French phrase that loosely translates to "leaning back in order to jump higher." "Part of leaning in means not trying to outdo men chasing a flawed notion of success," she said.

REPEAT: "I DON'T SHINE IF YOU DON'T SHINE."

Writer Ann Friedman coined "shine theory" to mean that women should surround themselves with other witty, accomplished women, not feel intimidated by them. "I want the strongest, happiest, smartest women in my corner," she wrote in 2013.[3]

1. http://mashable.com/2015/08/26/women-helping-women-at-work/
2. http://www.huffingtonpost.com/sheryl-sandberg/together-women-can-celebrating-the-power-of-women-helping-women-at-work_b_10622996.html
3. http://nymag.com/thecut/2013/05/shine-theory-how-to-stop-female-competition.html



Feature

ACTIVISM

Is at the Core of Physics

BY RACHEL KAUFMAN

Contributing Writer

A physicist and a #BlackLivesMatter activist. An astronomer and a feminist. A biophysicist and an LGBTQ advocate. Many physicists are finding that it is now not just possible but crucial to be both scientist and activist.

Jorge Moreno, an astrophysicist who studies galaxy formation at Cal Poly Pomona, is an outspoken advocate for advancing minorities in physics. "I knew I was not represented in my field," he says. "Students look up to me; I don't have the luxury to stay silent."

Moreno works to provide students of color with opportunities to explore more fields that might interest them, for example, partnering with John Johnson of Harvard to establish the Banneker Institute and Aztlán Institute, summer programs to prepare undergraduates of color for astronomy graduate programs. He is also outspoken on social media and on the blog Astronomy in Color.

But why speak out at all? Why march, why protest? Isn't physics, after all, inherently apolitical? That's an argument that people have been making for decades, and, Rosenthal and Moreno say, is wrong.

While some of the tactics or initiatives used by modern physicists are new, the presence of activism in physics goes back decades.

In the late 1960s a group of scientists, frustrated with the role physicists played in developing instruments of war, founded the radical group Science for the People, which addressed issues like the militarization of scientific research, the corporate control of research agendas, and more. The group was active for nearly two decades, and a new generation is reviving it for all branches of science, writing, "Some of the issues we face today have changed in important ways, but fundamental questions of power, ideology, and democracy in science remain."[1]

Physicists also played roles in other groups, like the illustrious Students for a Democratic Society (SDS). Frank Rosenthal, now 72, dates his activism back to his days as a graduate student in nuclear physics at Columbia.

"I was a grad student and my advisor had given me an assignment to work out the differential equations of consecutive [nuclear] decay. It was really boring, and I was looking at the student newspaper, and it said 'Rally Today.'" He walked out of his office straight to an SDS rally that ended up becoming the famous Columbia takeover of 1968, in which SDS and Student Afro-American Society occupiers took over multiple buildings on the Columbia campus for days.

"I was in Fayerweather Hall—we called it the Fayerweather Commune," he says. They stayed there six days, although Rosenthal remembers leaving each night to refill dewars with liquid nitrogen to keep his germanium detectors from drifting—science waits for no one, after all. "I told them I had to go back—I had a key, I went to the lab, filled up the nitrogen dewars, and then came back."

DURING THE HEIGHT OF THE 1968 PROTESTS AT COLUMBIA UNIVERSITY, American political activist Mark Rudd, a leader of Students for a Democratic Society (SDS), reads the organization's 'Student Demands to School Administration' through a bullhorn to assembled students and journalists, New York, New York, September 20, 1968. Photo by Fred W. McDarrah/Getty Images.

THE POLITICS OF SCIENCE

But why speak out at all? Why march, why protest? Isn't physics, after all, inherently apolitical? That's an argument that people have been making for decades, and, Rosenthal and Moreno say, is wrong.

"I think that argument," Moreno says, "comes from people who haven't experienced oppression."

The good news is that good physicists are swayed by data. "I give them anecdotes and data about harassment, and they begin to understand," he says.

Further, science may have an "objective reality"—"The charge on the electron is not political," as Rosenthal puts it, but doing science is inherently political. "What questions [are you asking?] Who's doing it? Who wants it to get done, and what are they using the results for?"

WHAT COMES NEXT?

Many activists are worried about the election of Donald Trump to the highest office in America, expressing concern that a man who ran his campaign on divisive rhetoric will undo much progress that has been made in the country. Moreno explains what comes next with—fittingly—an astronomy metaphor.

"If people in government say it's okay to do certain things, that emboldens people who are in the extremes. I've heard of many incidents of harassment, even on university campuses," he says. "[But] this is a solar flare. Many people are [only] noticing this [now] because they have never experienced racism. I've experienced racism all my life. I've always seen the sun; now it's a little intensified. The rules have changed, but I think there are many good people in astronomy who will protect people of color and women." //

1. https://scienceforthepeople.org/about/

PHYSCON RECAP

Unifying Fields: Making Connections AT PHYSCON 2016

by Bill DeGraffenreid, PhD, and Steve Feller, PhD
Co-Chairs, 2016 Sigma Pi Sigma Quadrennial Physics Congress Planning Committee

ABOVE: Scenes from PhysCon 2016. Photos courtesy of the American Institute of Physics.

"The woman who discovered pulsars knew me by name." When Kristine Romich of the City Colleges of Chicago arrived at the 2016 Sigma Pi Sigma Quadrennial Physics Congress in San Francisco, CA, she quickly had to shift her mindset from being the only physics major at her school to suddenly being surrounded by 1,200 like-minded individuals who were just as fascinated with the secrets of the universe as she was. Little did she know that by the end of the three-day event, she would also count the honorary conference co-chair, Dame Jocelyn Bell Burnell, as a mentor and a friend.

Kristine's story is just one of the thousands written November 3–5, 2016, at PhysCon. Over the course of the event, participants were treated to six inspiring plenary talks, three dynamic undergraduate poster sessions, eight interactive workshops, tours of four hotbeds of science and technology, and uncountable opportunities for networking. Plans were hatched to reinvigorate or even launch SPS chapters, and lifelong friendships got their start at the APS Dance Party, during several catered meals, through impromptu study sessions in the hotel atrium, and while watching the Cubs win the World Series. Discussions and presentations intertwined and reached a crescendo at the closing banquet with an outstanding keynote on gravitational waves by Patrick Brady of LIGO.

The following pages provide just a glimpse of some PhysCon 2016 highlights. Over the coming issues of *The SPS Observer*, we'll dive deeper into the many elements of PhysCon 2016 and hear from a spectrum of voices reflecting on their transformational experiences. Watch these pages to discover what really happens behind the scenes at SLAC, learn the secrets of the universe from Neil Turok, and find out how more than 1,000 attendees from over 180 colleges and universities came together to prototype innovations that will transform the future. Readers will also be among the first to find out where and when we are headed for the next PhysCon! //

physcon

2016 Quadrennial Physics Congress

“By far the most valuable thing I took from PhysCon is the network of connections I built there. I am touched by the amount of support I received at PhysCon—support both for my project and for my future as a physicist.”

—Kristine Romich, City College of Chicago

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

"During the weeks leading up to PhysCon, I was contemplating if physics was the right path for me. I was trying to find what my passion was, but I just couldn't find a branch of physics that really intrigued me. It wasn't until I attended Patrick Brady's seminar at PhysCon that I realized how fascinating astrophysics was to me. Ever since I was young, I was always interested in space. I had always been mesmerized by the endless vacuum that our planet lies within, however the idea of merging both my passion for physics and astronomy had never crossed my mind. After listening to Professor Brady's lecture on the scientific breakthrough of gravitational waves, I finally understood where my future as a physicist was headed."

– Letrell Harris, Hampton University

phys con

2016 Quadrennial Physics Congress

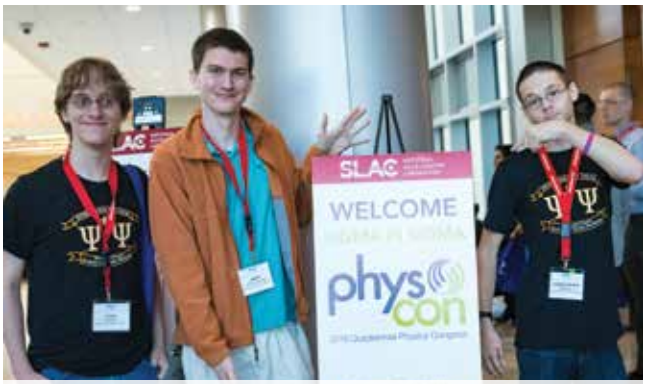
Dr. Patrick Brady presents "The Dawn of Gravitational-Wave Astronomy."

AIP CEO Robert G.W. Brown hits the dance floor at "The Silicon Dance Party" sponsored by the American Physical Society.

Attendees engaged in discussions at various workshops, while moderators known as "Workshop Wizards" facilitated discussions.

"Looking ahead to what I might do with a degree in the theoretical aspects of astroparticle physics, the early highlight of PhysCon came with my tour of SLAC. Operated by Stanford University, the SLAC National Accelerator Laboratory has made several remarkable breakthroughs in precisely the areas of physics I'm enthralled by! Although learning the history and touring the facilities were fantastic, the moment that really struck me was seeing a detailed Periodic Table of the Elements over the desks. Especially after I encountered another one hanging in a different cubicle area, I realized that these weren't just ornamentation – they're for reference as well. I always find it inspiring to see what we learn in school actually being used in our desired professions! Even more excitingly, I could be coming back to SLAC to conduct my own research someday!"

– Kathleen Hamilton, Howard Community College



Students toured the SLAC National Accelerator Laboratory, one of several tour options included in registration.

Images courtesy of Ken Cole and Matt Payne.

Plenary speaker Persis Drell (top, center) engages with students at the Breakfast with the Scientists event.

Dr. S. James Gates presents “L'arte della fisica (The Art of Physics), Accessing My Creativity App.”

SPS President DJ Wagner (left) stands with her students from Grove City College.

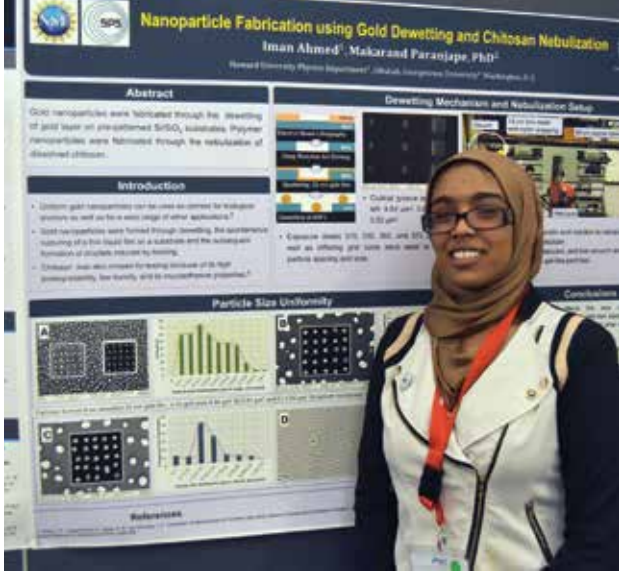
Sandy Spicer from Siena College takes questions from Dame Jocelyn Bell-Burnell at the poster sessions.

PhysCon 2016 in focus

- 1,118 attendees
- 34% female, 66% male
- Representation from 45 states, DC, Puerto Rico, Canada, Hungary, and Mexico
- Representation from 186+ colleges and universities
- 349 poster presentations
- 72 attendees from historically black colleges and universities or minority-serving Institutions received an NSF travel scholarship covering their registration, airfare, and hotel and all presented their research
- $33,973 donated by individuals in the SPS/Sigma Pi Sigma community to support student travel

Jordan Rice, Carthage College, is pictured with her piece “We are all made of starstuff,” which won first place in the Unifying Fields (Mixed Media) category.

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


Nanoparticle Fabrication using Gold Dewetting and Chitosan Nebulization
Iman Ahmed[1], Makarand Paranjape, PhD[2]
Abstract
Dewetting Mechanism and Nebulization Setup
Introduction
Particle Size Uniformity
Conclusions
References


FRESN


GRAND PENINSULA
STRAIGHT OUTTA QUANTUM
STRAIGHT OUTTA QUANTUM
STRAIGHT OUTTA QUANTUM

PhysCon Diversity TRAVEL AWARD

Through a grant from the National Science Foundation to the American Institute of Physics and the American Physical Society, 72 full travel awards (registration, travel, and lodging) were provided to students attending minority-serving institutions (MSIs) and historically black colleges and universities (HBCUs) to attend PhysCon 2016 and present their research. This funding helped to ensure that PhysCon 2016 was not only the largest meeting in its history, but also the most diverse and inclusive of traditionally underrepresented groups. Recipients included the following students:

ALABAMA A&M UNIVERSITY
Brianna Kenney
Khyana Price

CALIFORNIA STATE POLYTECHNIC UNIVERSITY, POMONA
Katelyn Helmuth
Lauren Keyes
Kevin Le
Jase Nosal

CALIFORNIA STATE UNIVERSITY, CHICO
Charles Payne
Elizabeth Pham
Avi Radick
Cameron Sorensen

CALIFORNIA STATE UNIVERSITY, FRESNO
Felise Bloodgood
Katherine Elder
Shoji Hishida
Annette Lopez

CALIFORNIA STATE UNIVERSITY, SACRAMENTO
Anthony Asuega
Mark Cratty
Aleksandar Tadic
Leah Weston

CALIFORNIA STATE UNIVERSITY, STANISLAUS
Salvador Montes

CITY COLLEGES OF CHICAGO
Kristine Romich

DILLARD UNIVERSITY
Wydglif Dorlus
Dava Johnson

HAMPTON UNIVERSITY
Tracy Edwards
Angelina Gallego
Letrell Harris
Maurice Roots
Keith Tukes

HOWARD COMMUNITY COLLEGE
Kathleen Hamilton

HOWARD UNIVERSITY
Iman Ahmed
Sirak Fessehaye
Pawan Gaire
Naomi Haddock
Keenan Hunt-Stone
Pradip Kattel
Rishap Lamichhane
Prakash Regmi
Kishor Subedi

LAMAR UNIVERSITY
Carlos Caballero

LOYOLA MARYMOUNT UNIVERSITY (CA)
Luciano Manfredi

MOREHOUSE COLLEGE
Xavier Bonner
Jeffrey Butler
Nyles Fleming
Dakari Franklin
David Holden
Justin Johnson
Melvin Kenney III
Khensu-Ra Love El
Jared Mitchell
Samori Roberts
Umaru Waizoba

NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY
Jared Canright
Sebastian Hendrickx-Rodriguez
Cameron Kimber
Samuel Montgomery

NORFOLK STATE UNIVERSITY
Thomas Coleman

SAINT PETER'S UNIVERSITY (NJ)
Nnamdi Ike
Edwin Rivas

SPELMAN COLLEGE
Najma Thomas

ST. MARY'S UNIVERSITY (TX)
Iliana De La Cruz
Matthew Knodell
Kaydian Quintero
Aaron Rodriguez
Raul Rodriguez

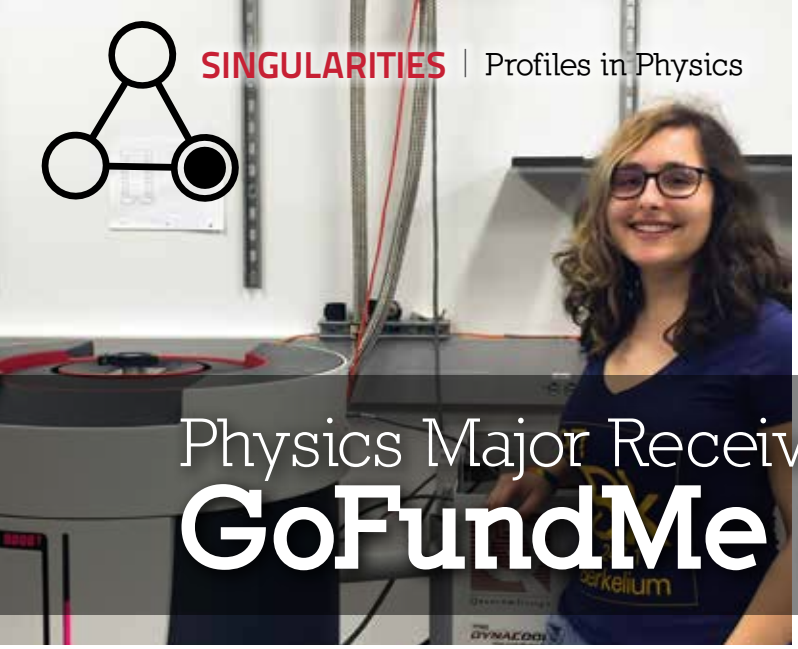
TEXAS LUTHERAN UNIVERSITY
Maegan Idrogo
Jaclynn Lewis
Daniel Morales
Clifford Pack
Patricia Snow

UNIVERSITY OF ALABAMA AT BIRMINGHAM
Lamario Williams

UNIVERSITY OF TEXAS AT ARLINGTON
Niyousha Davachi

UNIVERSITY OF TEXAS AT SAN ANTONIO
Diego Fausett

XAVIER UNIVERSITY OF LOUISIANA
Ke'La Kimble



Physics Major Receives GoFundMe Scholarship

by Kendra Redmond, Contributing Writer

Physics major Mayia Vranas was recently awarded one of ten $10,000 scholarships from the crowdfunding platform GoFundMe. Winners were chosen on the basis of having overcome obstacles, showing great character, and demonstrating academic promise.

Inspired by her physicist father, Vranas' childhood dream was to earn a physics PhD and be a professor at a leading university. Her path has been a challenging one, starting with a diagnosis of Tourette's Syndrome and Obsessive Compulsive Disorder in third grade, and later with depression and anxiety. An academically gifted student, she struggled to stay mentally challenged in school while keeping anxiety, excitement, sleep, and stress in check to avoid exacerbating the motor and vocal tics caused by Tourette's, which are often painful and tiring.

Vranas, now a sophomore at Berkeley and co-vice president of the SPS chapter there, is on track to reach her goal. She is a researcher in a condensed matter lab, where she contributes to research on the exotic magnetism of lithium iridates, which exhibit frustrated magnetism due to their honeycomb lattice structure. She has also established a mentoring program for incoming physics majors through SPS. "Mayia knows the many challenges that minorities in the field face, and through contributing to the community, she hopes that she will make it easier for diverse individuals to prosper," wrote Vranas' mother on the scholarship entry.

The SPS Observer asked Mayia to tell us more about her SPS experience and what this scholarship means to her.

HERE IS WHAT SHE HAD TO SAY:

I am extremely honored to receive this scholarship from GoFundMe. Becoming a physics major at UC Berkeley has been both challenging and rewarding. As a person with a disability and an aspiring physicist, every aspect of my life has been a balancing act; I must struggle to maintain my sleep and health while also maintaining my schoolwork and passion.

TOP LEFT: Mayia Vranas in front of her lab's physical property measurement system. Photo courtesy of Mayia Vranas.

TOP RIGHT: Mayia Vranas (center) with Maccallum Robertson and Victoria Sosnovtseva posing for UC Berkeley's "Big Give" fundraiser. Photo courtesy of Keegan Houser.

There have been times where I felt inadequate because I did not have time to learn the material at the depth that I hold myself to. Being part of Berkeley's Society of Physics Students has helped me find my place in the intense academic environment.

Meeting other physics majors at the end of their undergraduate paths and absorbing their advice and wisdom has helped me build the confidence I need to succeed, both as a physicist and as a student. Though they each had different experiences, these students all were going through exactly what I was—the feeling of inadequacy, the crunch to learn, and the difficulty of finding balance.

After finding a home in my SPS community, I decided to become involved, running for co-vice president. In this position, I hope to continue to foster and develop the supportive environment that has helped me succeed. Physics is a collaborative effort among many diverse individuals to discover and understand something bigger than us all, and I want to help make sure that everyone coming into the field feels at home.

ABOUT THE SCHOLARSHIP

GoFundMe is a crowdfunding platform. In response to the number of students creating GoFundMe pages to help them pay for higher education, last fall the company encouraged students to start fundraising pages tagged with #GFMScholarship and share their stories. Parents, friends, and mentors were also able to create pages on behalf of students. Those who received contributions from at least ten unique donors were reviewed by GoFundMe judges, who selected ten winners of $10,000 each. For details, visit the GoFundMe scholarship page at https://pages.gofundme.com/gfmscholarship_1/. //

Zone 9 Meeting:

Battling it out in Platteville

by Eric Cinnamon, University of Wisconsin – Platteville

Battling to the death… of a balloon! That was the main entertainment at the SPS Zone 9 meeting this year, with five universities attending the festivities.

The battle bots, made from kits designed by members of the UW-Platteville SPS chapter, were built to resemble Mario Party bumper balloon cars. The teams in attendance assembled their bots and modified them as desired. Each bot had some evolution of a sharpened stick on a servo and a balloon attached to the back end. A popped balloon signaled the temporary death of a bot! A number of bots also fell into the pit of doom—a bridge-crossed pit filled with T-shirts.

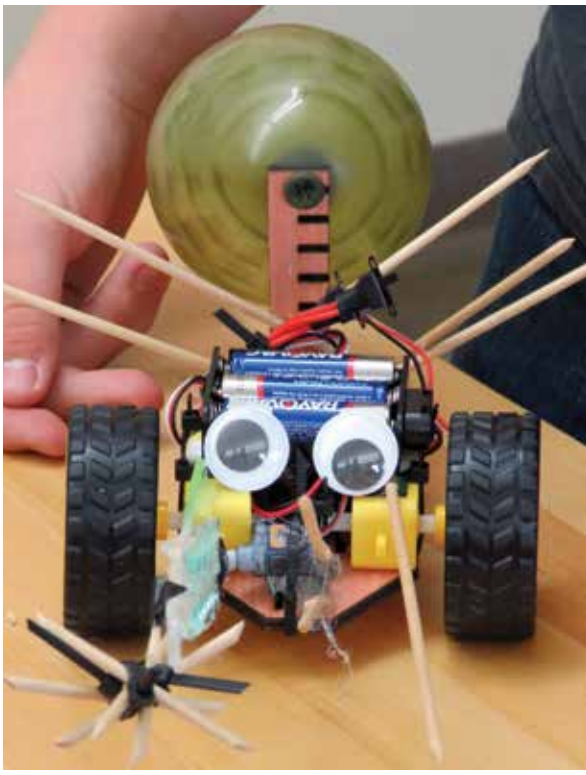
The tournament was one of the highlights of the "Battle Bots! Edition" of the Zone 9 meeting in November, hosted by the University of Wisconsin – Platteville. UW-River Falls, Ripon College, St. Norbert, and Carthage College sent members of their local SPS chapters to enjoy the action.

The meeting started Friday night with pizza and making liquid nitrogen ice cream, followed by a number of student speakers. Topics included projects on the IceCube Neutrino Observatory, piezoelectric sensors, and neutron monitoring.

Saturday morning, we kicked the day off by building battle bots before beginning the epic tournament. It was won by Frederic the Conqueror, a battle bot built by a UW-Platteville student.

After the carnage of bots, the whole crew enjoyed lunch before listening to a variety of faculty speakers. Dr. Neil Duffie, professor emeritus of UW-Madison, gave a keynote talk regarding control theory and industry decision-making optimization. Finally, two professors and a student from UW-Platteville gave talks on quantum dots, carbon nanotube transistors, and creation and application of nanoscale membranes.

Our favorite things from the meeting were the chance to do fun science with new people, meet students from other chapters, learn about the specialties of other schools, make ice cream, and see battle bots hang by their balloons over the pit of doom. //



A BATTLE BOT READY for battle. Photo courtesy of the University of Wisconsin – Platteville SPS chapter.

JOIN IN!

For information on regional SPS zone meetings, visit the SPS website at https://www.spsnational.org/meetings/zone-meetings.

MORE FALL 2016 ZONE ACTION

SPS Zone 5 met at the University of North Carolina at Asheville in November. Highlights included trivia, Physics Jeopardy, workshops on finding a career in physics and graduate school, a gravitational waves plenary, and a poster session.

SPS Zones 13 and **16** met jointly with regional sections of the American Physical Society and The American Association of Physics Teachers in October, hosted by New Mexico State University and the University of Texas, El Paso, in Las Cruces, New Mexico. Highlights included a talk by Stephen Cass, coauthor of the Hollyweird Science book series, along with research talks and posters.

LEFT: Wren Gregory (L) and Ashlyn Rickard (R) told students what graduate school is really like during their workshop, and posed here with SPS Director Brad Conrad. Photo by Michael Ruiz, UNC Asheville.

Inaugural Conference for Undergraduate Underrepresented Minorities in Physics

by Donna Hammer, Director of Education and SPS Advisor, University of Maryland

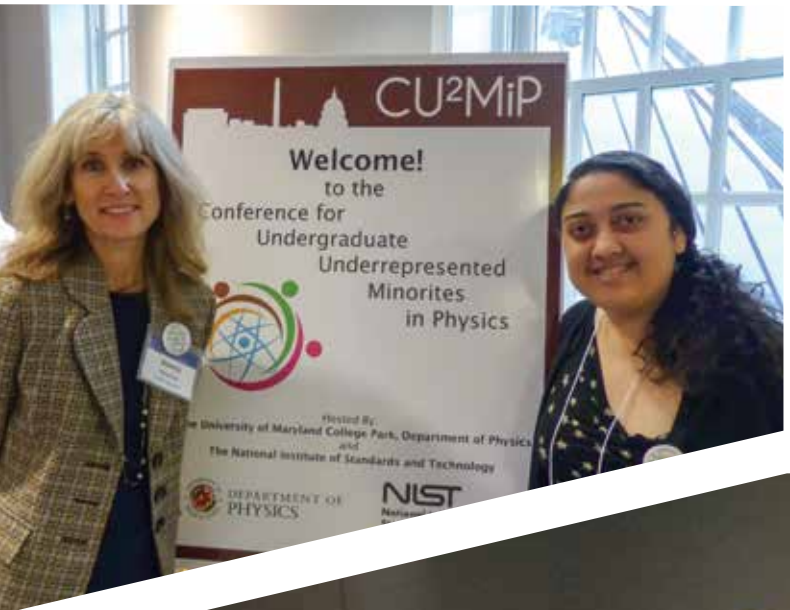
On October 7–9, 2016, the University of Maryland (UMD) Department of Physics and National Institute of Standards and Technology (NIST) hosted the first Conference for Undergraduate Underrepresented Minorities in Physics (CU²MiP).

During the inaugural event, students from across the mid-Atlantic region were invited to participate in networking, career advice, research opportunity workshops, and seminars.

Through this conference, students networked with their peers and employers, and had the opportunity to present their research and experience to a leading national laboratory through the partnership with NIST.

This community-building conference provided undergraduate underrepresented minority students with information about graduate programs and professions in physics, peer connections to others within the community, and for some, their first experience at a professional conference. As evident from the multitude of research by the American Institute of Physics, women and ethnic minority students are consistently underrepresented within many STEM fields, but are particularly sparse within physics undergraduate programs and careers. Building a sense of community and inclusion is vital to cultivating a diverse and representative society of physicists. CU²MiP encouraged a sense of connection among attendees and promoted awareness of the different career opportunities available to them.

The conference opened Friday with a welcoming address by Nobel laureate and distinguished university professor Bill Phillips, who spoke about having fun while pursuing a physics career. He also spoke with sadness of Katharine Blodgett Gebbie, the retired director of NIST's Physical Measurement Lab, who was pivotal in helping to organize the CU²MiP, but who had passed away earlier



LEFT: Donna Hammer, Director of Education and SPS chapter advisor, with Sarah Monk, SPS president, at the CU²MiP Poster Session. Photo courtesy of Troy Crosby, University of Maryland.

BELOW: CU²MiP participants share outcomes from group discussions during the "I, too, am..." Stereotyping and Microagressions Workshop. Photo courtesy of Donna Hammer, University of Maryland.

that year. She had greatly looked forward to meeting the students of CU²MiP, Phillips said.

After a full afternoon of NIST lab tours, the conference attendees enjoyed dinner and talks by UMD distinguished university professor Jordan Goodman, NIST director Dr. Willie E. May, and University of Maryland Baltimore County (UMBC) professor of physics Anthony Johnson. Saturday's activities included a welcome by alumna Delilah Gates, '15, now a graduate student at Harvard, and a talk by mathematician and UMBC County president Freeman A. Hrabowski III, which received a standing ovation. Interactions with representatives from professional societies and workshops on graduate school, research opportunities, and career paths ensued. A poster session preceded dinner, and regents professor Jim Gates gave the evening address. The UMD chapter of the Society of Physics Students then sponsored a physics trivia night.

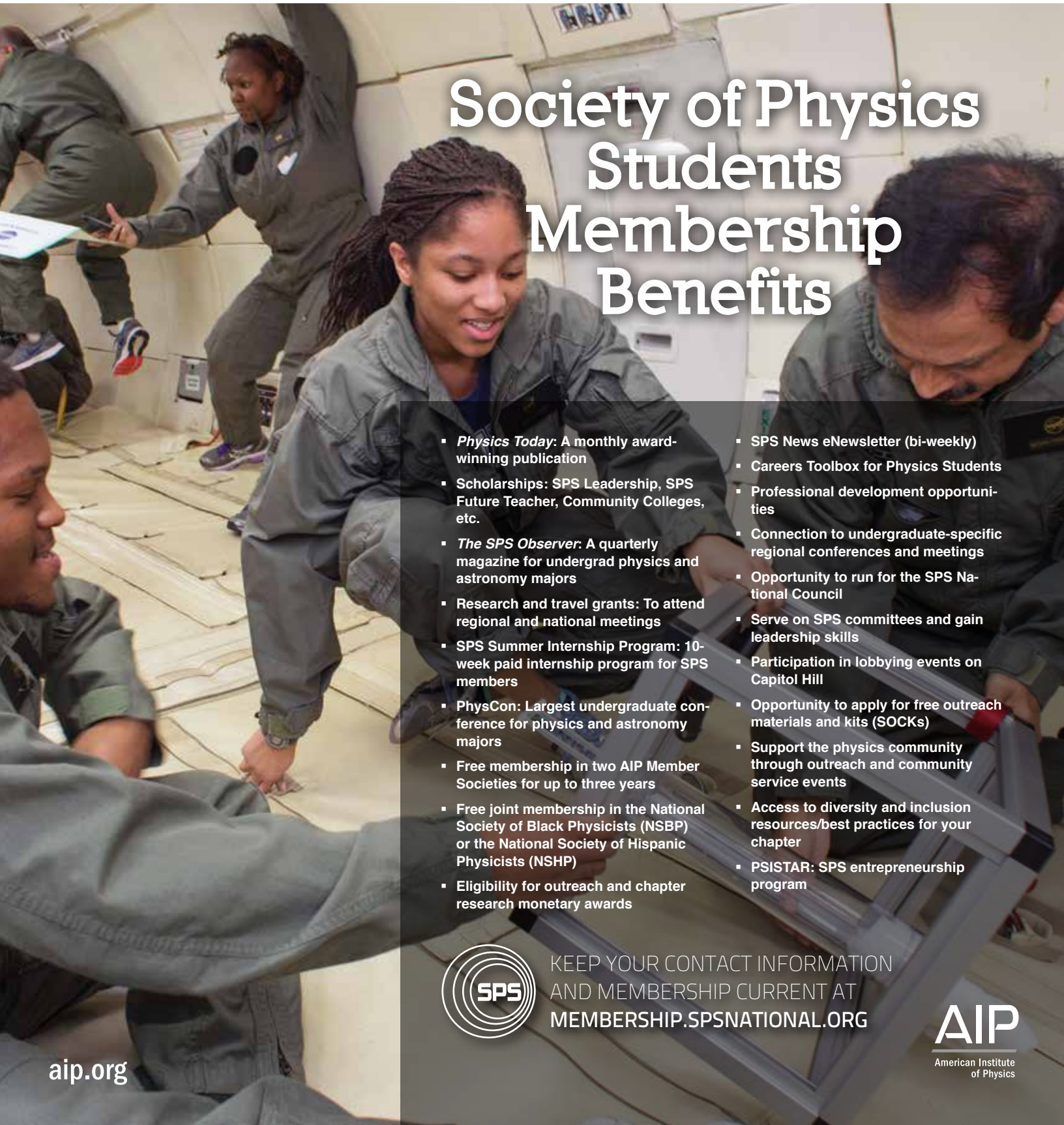
Sunday's agenda included a talk by Dr. Tabbetha Dobbins of Rowan University, a community-building session, and an address by UMD department chair Steve Rolston. Several UMD physicists participated in "Exploring Careers in Physics," which highlighted the many ways that the analytical skills, knowledge, and technical expertise that accompany physics degrees can be put to use in academia, government, and industry. UMD undergraduates Paula Rodriquez and Myles Poole offered closing remarks.

Due to the great success of the inaugural event, Hammer and others are already hard at work planning the 2017 CU²MiP. Slated for October 6–8, the upcoming CU²MiP will once again provide a safe space for community members to discuss topics that most affect them. The SPS National Office will partner with the University of Maryland and NIST to provide opportunities for greater participation across the entire country. //

LEFT: Speakers Brad Conrad, Robert Brown, and Ted Hodapp with CU²MiP organizers Donna Hammer UMD and Angie Hight Walker NIST. Photo courtesy of Troy Crosby, University of Maryland.

BELOW: CU²MiP participants touring the NIST Center for Neutron Research. Photo courtesy of Donna Hammer, University of Maryland.

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



Society of Physics Students Membership Benefits

- *Physics Today*: A monthly award-winning publication
- Scholarships: SPS Leadership, SPS Future Teacher, Community Colleges, etc.
- *The SPS Observer*: A quarterly magazine for undergrad physics and astronomy majors
- Research and travel grants: To attend regional and national meetings
- SPS Summer Internship Program: 10-week paid internship program for SPS members
- PhysCon: Largest undergraduate conference for physics and astronomy majors
- Free membership in two AIP Member Societies for up to three years
- Free joint membership in the National Society of Black Physicists (NSBP) or the National Society of Hispanic Physicists (NSHP)
- Eligibility for outreach and chapter research monetary awards
- SPS News eNewsletter (bi-weekly)
- Careers Toolbox for Physics Students
- Professional development opportunities
- Connection to undergraduate-specific regional conferences and meetings
- Opportunity to run for the SPS National Council
- Serve on SPS committees and gain leadership skills
- Participation in lobbying events on Capitol Hill
- Opportunity to apply for free outreach materials and kits (SOCKs)
- Support the physics community through outreach and community service events
- Access to diversity and inclusion resources/best practices for your chapter
- PSISTAR: SPS entrepreneurship program

SPS

KEEP YOUR CONTACT INFORMATION AND MEMBERSHIP CURRENT AT
MEMBERSHIP.SPSNATIONAL.ORG

AIP
American Institute of Physics

aip.org