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ON THE COVER

In this issue we explore physics beyond your backyard, with a focus on networking, professional societies, the SPS Jobs site, and student conferences—including a preview of PhysCon 2016, the largest gathering of undergraduate physics students in the United States.



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 exper-

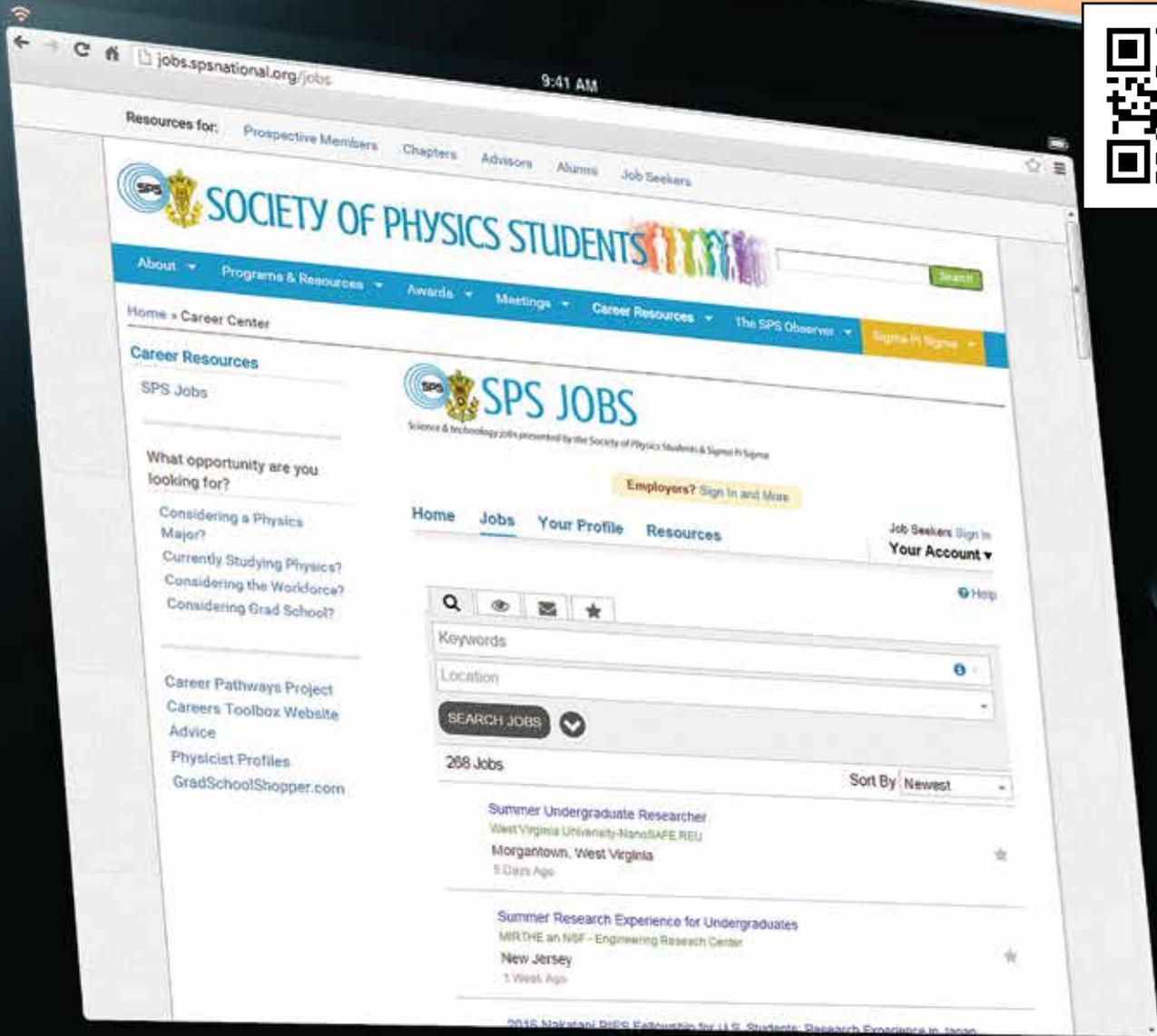
tise in physics education and student programs, science communication, government relations, career services for science and engineering professionals, statistical research in physics employment and education, industrial outreach, and the history of physics and allied fields. AIP publishes *Physics Today*, 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 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



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<http://jobs.spsnational.org>

partner in the AIP Career Network

Why Join a Professional Society?

by DJ Wagner

Professor of Physics at Grove City College in Pennsylvania, and President of the SPS & Sigma Pi Sigma National Council

Membership in the Society of Physics Students makes you part of a professional society devoted to physics students and their mentors. It also allows you to pick two other American Institute of Physics member societies to join, and provides free enrollment in the National Society of Black Physicists and the National Society of Hispanic Physicists.

These sound like exciting opportunities, and they are. Let's look a bit more into *why* joining professional societies is a smart move.

The most obvious reason to join a professional society is because it's what professionals do. You become a member of a community of individuals with common interests and goals, supporting the future development of your profession. Professional societies communicate with members of Congress, educate the (tax-paying) public about the importance of their profession, and carry out many other activities that promote that profession (thereby increasing your chances of continued employment in that profession).

Member societies also provide opportunities to meet future collaborators, employers, and employees. My first job came because of a chance meeting at a conference I attended while in graduate school. Had I not met that person (and had he not



encouraged me to apply for the job), I probably would not have applied. While online networking can be very important too, it does not replace the spontaneous face-to-face conversations that occur when you participate in society meetings or get involved in your society. Other interactions at professional conferences and SPS activities have led to insights helpful to my work, information on funding opportunities, collaborations, and good friendships.

Professional societies provide many other resources that can help you as you pursue a career: job listings, advice articles, and webinars on job searching; newsletters with announcements relevant to your professional interests; information about funding opportunities; publications from the top journals in your field; tailored topical groups where you can connect with others facing similar challenges and interests; etc. SPS in particular has many scholarships, travel awards, and research prizes available to undergraduate student members.

If you aren't currently a member of a professional society, I encourage you to join at once. Join SPS. Take advantage of the free AIP member society memberships. Continue your affiliation with professional societies in your chosen field after you graduate to benefit from all they can offer. //



SPS PRESIDENT DJ WAGNER PARTICIPATES IN THE STUDENTS EXPLORING ENGINEERING AND SCIENCE (SEES) OUTREACH EVENT at the 2014 American Association of Physics Teachers (AAPT) Winter Meeting in Orlando, FL. This program, sponsored by AAPT and the Society of Physics Students, provides 100 minority, low-socioeconomic students with the opportunity to engage in three hours of hands-on science activities during the AAPT Winter Meeting each year. Photos courtesy of the American Institute of Physics.



Fall 2015 Award Recipients

SPS CONGRATULATES THESE CHAPTERS AT SCHOOLS ACROSS THE COUNTRY

FUTURE FACES OF PHYSICS AWARD

Several awards of up to \$500 are made each year to chapters for outreach designed to promote physics across cultures.

COLORADO SCHOOL OF MINES

Future Faces of Physics with CSM SPS

Project Leader: David Schmidt

SPS Advisor: Chuck Stone

RHODES COLLEGE

Can You Hear Me Now: Supplementing Memphis City Schools with Acoustics Labs

Project Leader: Eleanor Hook

SPS Advisor: Brent Hoffmeister

TEXAS STATE UNIVERSITY

Taking Classroom Physics Further: Promoting Interest in Physics in the Local Community

Project Leader: Elizabeth LeBlanc

SPS Advisor: David Donnelly

TEXAS LUTHERAN UNIVERSITY

The TLU SPS SYS-STEM Program

Project Leader: Vanessa Espinoza

SPS Advisor: Toni Saucy

UNIVERSITY OF THE SCIENCES IN PHILADELPHIA

The Future Faces of Physics: The Fundamentals

Project Leader: Katee O'Malley

SPS Advisor: Roberto Ramos

SPOTLIGHT ON:

Henderson State University 3...2...1...Blast Off! It Really is Rocket Science

Henderson State University's SPS chapter aims to blast off with underprivileged minority and female students from all high schools within a rural area of Arkansas. Proposed activities include simple experiments with water and air rockets to see how different variables affect flight.

Project Leader: Todd Baum

SPS Advisor: Shannon

Clardy

SPS CHAPTER RESEARCH AWARDS

Several awards of up to \$2,000 are made each year to chapters for research activities that are deemed imaginative and likely to contribute to the strengthening of the chapter.

SPOTLIGHT ON:

ITHACA COLLEGE

Creating a Creator: Using a 3D Printer to Build a 3D Printer from Scratch

The SPS chapter at Ithaca College, alongside the school's engineering club, seeks to construct a 3D printer from scratch. They will use parts printed from the school's existing 3D printer to gain new knowledge and experience while building a machine with incredible potential to aid future research projects.

Project Leaders: Nathan Antonacci, Andrea Santiago-Boyd, Jared Saltzman, Matthew Bellardini

SPS Advisor: Michael "Bodhi" Rogers

GEORGIA INSTITUTE OF TECHNOLOGY

Freshman Project: Electromagnetic Kinetic-Projectile Launcher

Project Leaders: Madeline Lazar, Trey Scheiper, Sujeeth Jinesh, Zachary Kennedy, Alex Buser, Sam Wiley, Eric Pretzsch, Douglas Stewart, Hannah Price, DeVon Ingram, Rhiannon Partington, Talha Irfan, Kenny Higginbotham, Jada Walters, Matthew Schulz, Sally Hannoush, Michael Barnhill

SPS Advisor: Edwin Greco

TUSKEGEE UNIVERSITY

Identification of Glasses Using Laser Induced Breakdown Spectroscopy (LIBS) Technology

Project Leader: Devin Hicks

SPS Advisor: Prakash Sharma

LAMAR UNIVERSITY

Finding the Shape of Glowing Objects from Polarimetric Measurements

Project Leaders: Keeley Townley-Smith, Mark Worth, Suzanne Wheeler

SPS Advisor: Crisitan Bahrin

NORTHERN VIRGINIA COMMUNITY COLLEGE

Physics of Propulsion and Levitation of a Self-Driven Electromagnetic Wheel

Project Leaders: Nathan Gaul, Hannah Lane

SPS Advisor: Walerian Majewski

MARSH W. WHITE AWARDS

Several awards of up to \$300 are made each year to chapters for physics outreach activities to grades K–12 and the general public.

SPOTLIGHT ON:

UNIVERSITY OF THE SCIENCES IN PHILADELPHIA

How Can Magic Be Physics?

Students at the University of the Sciences in Philadelphia plan to make magic more understandable. By utilizing a suite of magic tricks and illusions to open a doorway to physics, they hope to give high school students and their local community an understanding of physics that will stay with them beyond the outreach event.

Project Leader: Kacy Catalano

SPS Advisor: Roberto Ramos

CALIFORNIA STATE UNIVERSITY – CHICO

The Annual SPS Pumpkin Drop

Project Leader: David Ramirez

SPS Advisor: Eric Ayars

NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY

NMT Ballistics Bonanza and Other Outreach

Project Leaders: Jared Canright, Chip Dugger, Rebecca Proni, Ben Burnett

SPS Advisor: Paul Arendt

NORTHEASTERN UNIVERSITY

Boston WaterWorks

Project Leaders: Sarah Mailliet, Nicholas DePorzio

SPS Advisor: Swastik Kar

RHODES COLLEGE

Summer Squash: Watermelon Smashing at

Rhodes Rites to Play

Project Leader: Jordan Meyer

SPS Advisor: Brent Hoffmeister

GEORGE WASHINGTON UNIVERSITY

The Phun-damentals of Physics

Project Leaders: Srividya Murthy, Jacob Maibach, Kara Zielinski

SPS Advisor: Gary White

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Bringing Physics to the Community for

People of All Ages

Project Leader: Robert McGrath

SPS Advisor: Michael Vera

ADELPHI UNIVERSITY

Lab for Kids

Project Leaders: Yuhao Qiao, Brian Kaufman, Tracy Paltoo, Tara Pena, Nikolette DeBenedictis

SPS Advisor: Matthew Wright

CLEVELAND STATE UNIVERSITY

The Year of Light: Inspiring Kids with the Beauty of Physics

Project Leaders: Christian Gunder, Krista Freeman, Jim Pitchford

SPS Advisor: Kiril Streltzyk

UNIVERSITY OF THE SCIENCES IN PHILADELPHIA

The Future Faces of Physics: The Fundamentals

Project Leader: Katee O'Malley

SPS Advisor: Roberto Ramos

COLLEGE OF WILLIAM & MARY

Demos in the Sun: The Oobleck Experience

Project Leaders: Brandon Buncher, Jackson Olsen, Scott Mundy, Stephanie Wang

SPS Advisors: Irina Novikova and Seth Aubin

DREXEL UNIVERSITY

The Starch Difference

Project Leader: Mark Giovinazzi

SPS Advisor: Luis Cruz

HENDERSON STATE UNIVERSITY

Science Olympics

Project Leader: Todd Baum

SPS Advisor: Shannon Clardy

TOWSON UNIVERSITY

Science After Hours: Educating Young Students

Project Leaders: Nathan Prins, Kielan Wilcomb, Nick McKinley, Emileigh Shoemaker, Dan Zile

SPS Advisor: Phuoc Ha

WELCOME NEW CHAPTERS!

Congratulations and welcome to the newest SPS and Sigma Pi Sigma chapters, finalized in 2015:

SPS

- Alexandria University (Egypt)
- Chabot College (CA)
- Lee College (TX)
- Mercyhurst University (PA)
- Missouri Southern State University
- Victor Valley College (CA)

Sigma Pi Sigma

- Bridgewater College (VA)
- Florida Atlantic University
- Georgia College and State University
- Mercyhurst University (PA)
- Messiah College (PA)
- Missouri Southern State University
- Norfolk State University (VA)
- Salisbury University (MD)
- Xavier University of Louisiana



ABOVE: The University of the Sciences SPS team. Photo courtesy of the University of the Sciences.

TOP LEFT: The Ithaca College SPS team. Photo courtesy of Ithaca College.

SPS AWARD DEADLINES

SPS is recalibrating award deadlines for individual and chapter awards for the 2016–17 academic year. Please watch the SPS website for updates! Details on SPS awards can be found at www.spsnational.org/awards.

Compass Confusion

OUT OF LUCK IN THE OUTBACK

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

A Colorado outdoorsman vacationing in Australia wished to explore the outback on foot. He packed his gear, which included a fine magnetic compass passed down to him from his great-great-grandfather, who had been an explorer of the American West. The compass was an expensive one, made by the prestigious Tait Instrument Company of Philadelphia.

While hiking in the outback, he found that his compass wasn't functioning well at all. Its needle was sluggish, dragging on the base of the compass,

so he was unwilling to trust it. Thanks to some helpful and savvy Aborigines, who never used compasses, he found his way back to civilization. He related his sad story to his Australian friends.

They examined his compass and saw the finely engraved lettering "Tait's Compass" on the case. "We've seen this before when you blokes from the states bring

along one of these old compasses. We have a saying 'He who has a Tait's is lost.'"

WHAT WAS THE PROBLEM WITH THE COMPASS, AND HOW MIGHT OUR INTREPID EXPLORER HAVE OVERCOME IT?



USING A MAGNETIC COMPASS. Photo courtesy of the United States government printing office.

Feedback is appreciated from readers. 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 to dsimanek@lhup.edu. 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.

ANSWER TO THE COMPASS CONFUSION PUZZLE

You can compare the earth's near-dipole field to a short magnet with its south magnetic "pole" directed toward the north geographic pole of the earth. The magnetic pole of a compass needle is defined to be the "north-seeking" end, i.e., the end that "seeks" (points generally toward) the north geographic pole.

Small pocket compasses have a magnetic needle pointer balanced on a sharp pivot. In use, the compass case is held in a horizontal plane. In the northern hemisphere, the magnetic field dips downward toward the north (the dip angle), which would cause the north-pointing end of the needle to droop downward. To prevent this, compasses intended for use in the northern hemisphere have the south-pointing end of the needle weighted to balance it. If a north hemisphere compass is used in the southern hemisphere, the south pointing end of its needle would dip a lot more, since that is the weighted end and the field lines dip toward the south. The needle would likely drag on the base of the compass. Simple compasses for use in the southern hemisphere have the north-pointing end of the needle weighted to prevent this. In fact, manufacturers of compasses customize them for five separate geographic zones.

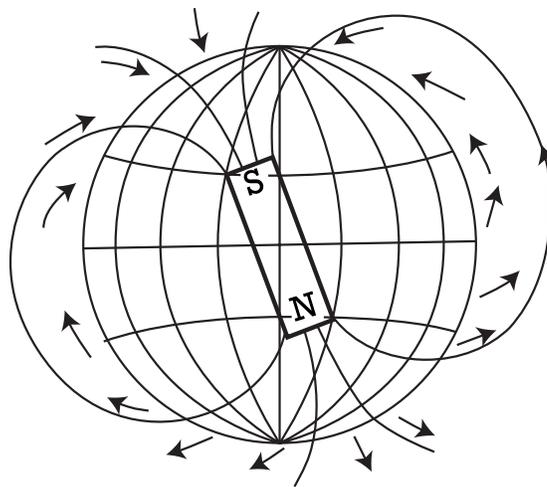
Magnetic compasses used by explorers of the American West were weighted for use in North America. Today one can buy compasses with "global needles" that work equally well in both hemispheres. They have a double system, pivoting the magnets and the needle separately, but coupled. The tilt of the internal magnet doesn't tilt the needle. Since our explorer's compass was so old, it did not have this newer mechanism.

Compasses for determining accurate direction with reference to maps are generally held horizontally, and some have devices for sighting landmarks on the horizon. Had

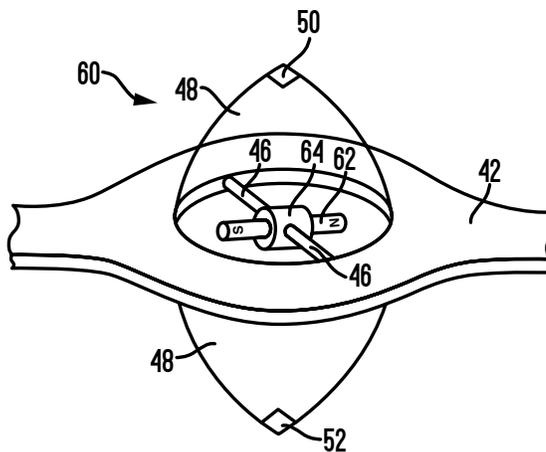
our explorer been more savvy about physics he might have tried holding his compass inclined at an angle until the needle moved freely. Raising it slowly to horizontal, being careful not to rotate it about a vertical axis, he could read the compass bearings correctly. Whether this would work would depend on how the magnetic needle was suspended.

This question arises frequently on the web, often with misleading and wrong answers. People ask, "Will a magnetic compass I use in the USA

also work in Australia?" One answer I've seen was "You need one with the needle magnetised the other way round, so it points south instead of north." This may have been a joke. It is true that near the magnetic poles simple magnetic compasses are less sensitive, because the horizontal component of the earth's field is weaker there. In Northern Canada and Southern Australia magnetic compasses perform poorly. But the north-pointing end points northward at mid latitudes in either hemisphere. //



MAGNETIC FIELD OF THE EARTH (IDEALIZED). Arrows show the direction a compass points. From Eldridge, John A. *College Physics*, 3rd ed., Wiley, 1947. Used with permission.



THIS SCHEMATIC SHOWS the inner workings of a modern global compass. Magnet at 64, needle at 42. Jeweled bearings at 46, 50 and 52. From US patent 7,194,814 B2. Used with permission.

Ithaca Mixes It Up with Printed Pancakes

KICKSTARTER ACQUISITION A BOON TO SPS CHAPTER'S 3D-PRINTING PROJECT

by SPS Staff

When Bodhi Rogers and his crew put on a show with their 3D printers, people always admire the objects on display. Students showcase keychains and magnets – even a prosthetic hand.



ITHACA COLLEGE USES ITS PANCAKEBOT to print SPS-inspired flapjacks. Photo courtesy of Bodhi Rogers.

But what really draws a crowd is a device Rogers recently purchased from Kickstarter: a PancakeBot.

"When I saw it, I knew I had to have it," says Rogers, a professor in the department of physics and astronomy and advisor for the SPS chapter at Ithaca College in New York.

The contraption works a lot like a regular 3D printer, which builds things by drawing thin layers of plastic. But instead of sketching in plastic, the PancakeBot uses batter.

Watching it in action is like watching a robot with a cake icer. A nozzle moves slowly back and forth, squeezing a stream of liquid flapjack onto a griddle. Parts of the design sketched first have more time to cook and turn out darker in the end, giving the final product different shades of brown.

For Rogers, the machine isn't just a fun prop; it's also a platform for education.

His chapter recently won a SPS Chapter Research Award to build a new 3D printer. Working with Ithaca College's engineering club, they plan to use their current trio of 3D printers to craft the parts for the new printer – buying only motors and electrical parts that can't be made in the lab. They call the project "Creating the Creator."

That promises to be a complicated task. Pancakes, it turns out, are simpler.

For one thing, the PancakeBot works only with two-dimensional designs. Writing the instructions to create those designs, stored in digital files, is easier than it would be for 3D designs, such as the parts for the new printer. Students can thus hone their skills.

The PancakeBot has also tested the chapter's mechanical aptitude. When a tube popped off its vacuum chamber, batter flooded the interior workings of the machine. Taking apart and reassembling the PancakeBot to clean it proved to be a learning experience.

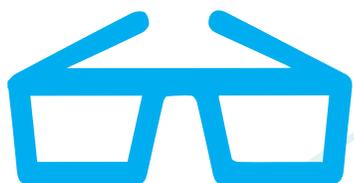
Pedagogical value aside, there's no denying that the new acquisition has boosted the popularity of this particular workshop in the building.

"You can smell it cooking all the way down the hall," says Rogers. "When we fire it up, there's a line out the door for pancakes."

It has also opened the door to a sweet new collaboration with the environmental sciences program at Ithaca College, which makes and sells maple syrup. //

GET INVOLVED

SPS chapters are eligible for up to \$2,000 in funding for research projects through the SPS Chapter Research Award. Applications are due November 15. For details see www.spsnational.org/awards/chapter-research.



Networking FOR NERDS

PROFESSIONAL SCIENCE SOCIETIES OFFER OPPORTUNITIES FOR CONNECTING

Alaina G. Levine, a former SPS chapter president, head of her own consulting firm Quantum Success Solutions, writer for the American Physical Society, and author of the book *Networking for Nerds*—credits much of her success to her strategies for turning small talk into lasting connections. She recently sat down with *The SPS Observer* to talk about how professional science societies and their conferences have been integral to her networking.

WHAT WAS YOUR FIRST CONTACT WITH A PROFESSIONAL SCIENCE SOCIETY BEYOND SPS?

My very first scientific conference that I ever went to: an APS March Meeting. That meeting changed my life in a very significant way. I had decided to hang out in the press room. This is something I encourage people who are interested in a communications career to do. You can even volunteer to work in the press room.

There I met the public relations director of APS, who would turn out to be very significant in my life. A few months after the meeting, he emailed me that he was vacating his job and asked if I would be interested in applying. He put me in touch with Alan Chodos, who was heading the search for his replacement.

I didn't take the job, but Alan and I started a series of conversations and a collaboration that lasted for 16 years. I did volunteer work and project work for him. I eventually pitched him an idea for a column in the monthly *APS News* called Profiles in Versatility about physicists in nontraditional careers. He accepted it, and he was my editor until he retired. And since 2014, David Voss is my editor. I still do occasional freelance work for Alan.

WHAT BROUGHT YOU TO THIS MEETING?

As an undergraduate who majored in math at the University of Arizona, I had worked as an assistant to the communications director. She left. After graduating, I decided to apply for her position and got the job.

The "aha" moment for me was truly recognizing that with an undergraduate degree in math or physical sciences, the universe is open to you to do anything. What I was very interested in was communications. Four years later I was hired by the



ALAINA G. LEVINE ON ASSIGNMENT FOR IEEE SPECTRUM

MAGAZINE, covering an engineer who works for a race car team. She wore the fire suit for protection because she was in the "pit" with the racing team. And she landed this gig through networking with a former physics major! Photo courtesy of Alaina G. Levine.

dean at the college of sciences to create opportunities for students who don't want to get a Ph.D., students who will work in industry. The abstract deadline for APS fell within a week or two of me getting this job. I ran to the dean and asked if I could go to it. To me it was like this magical place of gods and goddesses, celebrities that I had really admired in physics plus all these nerds and geeks who were so excited about physics. I turned in my abstract, and it was accepted, so I went.



LEVINE SIGNING COPIES OF HER BOOK, NETWORKING FOR NERDS, at the Tucson Festival of Books in 2016. The forward is written by Physics Nobel Laureate Brian Schmidt. Photo courtesy of Alaina G. Levine.

WHAT ADVICE DO YOU HAVE FOR UNDERGRADUATES ATTENDING A CONFERENCE?

One of the biggest things that you can do is to go through the program in advance and look for speakers you are interested in talking with, including people giving posters or exhibitors. Contact them and ask for 15-minute coffee appointments at the meeting. Most students don't do this. But professionals are usually very excited to talk to young early career scientists. You don't have to be an expert to meet with them. You're not expected to be; you're a student.

You can also volunteer to work at the conference. This gives you a reason to talk to people at the conference and



could open hidden career opportunities. I remember I was giving a talk once and my computer died. The student volunteer ran the length of the building to get me a new one. Will I help this student if they approach me again? You betcha.

I'm really into networking. When it's lunch time or dinner time, I always encourage people not to eat alone. Two years ago at the American Geophysical Union conference, I made a connection in a line for the ladies room; the woman standing in front of me worked for a nonprofit that I was interested in working with, so we exchanged cards and started a conversation.

When you see Dr. Nobel Prize walking down the hall by herself, take advantage of that moment. Introduce yourself and tell her that you're an undergraduate who is really interested in particle physics or whatever.

Opportunities like that are fleeting. And don't be shy about following up with people after the meeting. You never know what new opportunities will arise, months or even years later.

WHAT OTHER BENEFITS DOES AN UNDERGRADUATE GET FROM JOINING A PROFESSIONAL SCIENCE SOCIETY?

One perk you have as a member is access to the membership directory. Senior scientists access the directory for strategic networking, to find potential collaborators. Early career scientists tend not to think that way. But if you're interested in working in company X or country Y or industry Z, you could easily do a search in the membership directory and find people who are in those areas or might know people in those areas. Since you're both members, you have a perfect excuse for chatting. Reach out, set up a Skype call, say, "I want to learn more about what I can do to be successful."

Every professional organization operates through committees. They are always looking for students interested in serving. It's a great way to meet new people and gain leadership experience. And someone on the committee might think, "Wow, this person is doing such a great job. How great would it be if they interned at my lab or worked at my company?" //

LEVINE SERVED AS KEYNOTE SPEAKER on networking and accessing hidden career opportunities at the National Institute of Environmental Health Sciences. Photo by Steve McCaw.



Meet the AIP Member SOCIETIES

When you join SPS as an undergraduate, you get free membership in two of ten other physics societies, all of which are members of the American Institute of Physics (AIP). AIP serves this federation of physical science societies in a common mission to promote physics and allied fields.

Since you can do this for up to three years, you might consider joining different societies each year, trying out acoustics, crystallography, rheology, medical physics, or optics just to see what those societies have to offer. In any case, SPS is eager for you to see the breadth of physics through these societies, so indulge!

ACOUSTICAL SOCIETY OF AMERICA (ASA)

Purpose: To increase and diffuse the knowledge of acoustics and to promote its practical applications.

Benefits: *Journal of the ASA* online, *Acoustics Today* magazine, discounted registration at ASA meetings, special events for students at meetings.



AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE (AAPM)

Purpose: Seeks to promote the application of physics to medicine and biology.

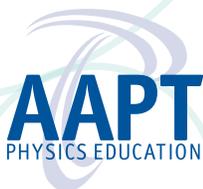
Benefits: *Medical Physics* online journal.



AMERICAN ASSOCIATION OF PHYSICS TEACHERS (AAPT)

Purpose: Promotes enhancing the understanding and appreciation of physics through teaching.

Benefits: Member discounts on AAPT products, access to members-only portion of AAPT homepage, student registration at AAPT meetings, online access to *The American Journal of Physics* and *The Physics Teacher*. Also access to local AAPT sections and more. See www.aapt.org/Resources/students.cfm.



AMERICAN ASTRONOMICAL SOCIETY (AAS)

Purpose: Promotes the advancement of astronomy and closely related branches of science.

Benefits: *AAS News Digest* and e-mail distributions, notices of meetings and grant programs, participation in AAS meetings at junior (student) member



registration rates, member rates on journal subscriptions, listing in AAS membership directories as "Society of Physics Students Member."

AMERICAN CRYSTALLOGRAPHIC ASSOCIATION (ACA)

Purpose: Promotes the study of the arrangement of the atoms in matter, its causes, its nature, its consequences, and the tools and methods used in such studies.



Benefits: *ACA Newsletter* (four per year), reduced meeting registration, right to vote in annual elections, *International Union of Crystallographers Newsletter*, reduced rates on ACA publications.

AMERICAN METEOROLOGICAL SOCIETY (AMS)

Purpose: Promotes the advancement of the atmospheric and related sciences, technologies, applications, and services for the benefit of society.

Benefits: *Bulletin* of the AMS, deeply discounted journal subscriptions and books, special rate for *Weatherwise* magazine, discounted meeting registration, eligibility for scholarships and fellowships, and participation in the AMS Student Conference.



AMERICAN PHYSICAL SOCIETY (APS)

Purpose: Promotes the advancement and diffusion of the knowledge of physics and all branches of fundamental and applied physics.

Benefits: *APS News* monthly, greatly reduced registration at APS general meetings, in-depth career guidance at meetings and online, join up to two free divisions or topical groups for timely information in your field, one free online APS journal subscription, access to the online APS Member Directory and other members-only websites, and all other privileges of full APS membership, including the right to submit papers to meetings, and vote in elections.



Continued on page 14





www.aps.org/nmc

A program that connects African American, Hispanic American, and Native American undergraduate students with faculty mentors and provides both with resources and support.



2016 NMC ANNUAL CONFERENCE
OCTOBER 21 - 23, 2016
 at the University of Houston
 Houston, Texas

Conference highlights:

- NASA tours
- An REU/Grad School Fair
- Undergraduate Research Poster Session
- SPS Careers Toolkit Workshop
- Professional development for students
- Travel Funding for NMC Mentors & Mentees available

Register Now
go.aps.org/nmc-conference

AVS: SCIENCE & TECHNOLOGY OF MATERIALS, INTERFACES, & PROCESSING

Purpose: Promotes communication and disseminates knowledge in vacuum science, technology, and engineering.

Benefits: Access to our online Publication Library, Technical Library, MyAVS, the member-only area, *AVS Newsletter*, as well as discounted symposia and short course registration.



THE OPTICAL SOCIETY (OSA)

Purpose: Promotes the generation, application, archiving, and dissemination of knowledge in optics and photonics. The society's purposes are scientific, technical, and educational.

Benefits: *Optics & Photonics News* print subscription; 50 downloads from the OSA Publishing Library, the world's largest peer-reviewed collection of optics and photonics information; substantial registration discounts to more than 40 conferences and meetings annually; the ability to network with peers and mentors through technical group affiliations; and engagement with more than 350 OSA Student Chapters all over the world.



THE SOCIETY OF RHEOLOGY (SOR)

Purpose: Promotes the advancement and applications of rheology, the science of deformation and flow of matter, and its applications.

Benefits: Access to the premier *Journal of Rheology*, published bimonthly; *The SOR Bulletin*, published semiannually; discounted registration for the society's Annual Meetings; personal and professional growth opportunities through discussion forums and networking opportunities. //



If you attended the USA Science and Engineering Festival in April in Washington, DC, you may have spotted a colorful tent with musical wine glasses, a bed of nails, and a giant smoke cannon. Yes, the physics circus had come to town, thanks to the combined efforts of the American Institute of Physics and many of its member societies. We had a great time being a part of the 3,000 free, hands-on science activities and 150 stage shows put on at the festival. Thank you to all of the local SPS and Sigma Pi Sigma volunteers who made the booth such a success!

BIG TOP PHYSICS WAS HOSTED BY THE FOLLOWING ORGANIZATIONS:

- AAPT: American Association of Physics Teachers
- AAS: American Astronomical Society
- ACA: American Crystallographic Association
- AIP: American Institute of Physics
- APS: American Physical Society
- ASA: Acoustical Society of America
- NSHP: National Society of Hispanic Physicists
- OSA: The Optical Society
- SPS/ΣΠΣ: Society of Physics Students/Sigma Pi Sigma





Find Internships and Research Opportunities **AT SPS JOBS**

SPS Jobs is the ideal place for undergraduates to find exciting job opportunities in science and engineering fields. Hundreds of current bachelor-level physics and engineering jobs are published in a searchable database each month in the industrial, academic, national laboratory, and nonprofit sectors. Exciting summer internships and Research Experiences for Undergraduates (REUs) are available for students still pursuing their degree who want to gain real-world experience. Job seekers registered with SPS Jobs can easily create job alerts notifying them of new listings that fit specific criteria, and may also post their resume or CV to the site to simplify online applications.

SPS Jobs also features an ever-expanding Career Resources section, offering job seekers helpful tips to assist them in the sometimes daunting job-hunting process. Information from SPS members detailing their own research experiences is available to provide students with an idea of the varied career paths that may be taken

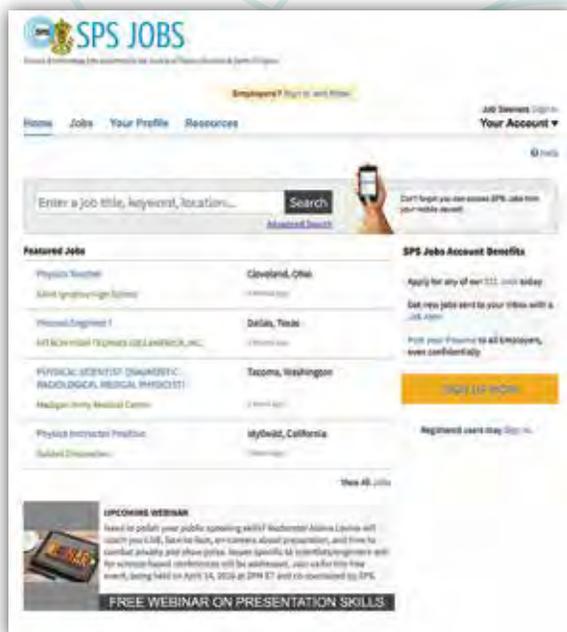
with a physics degree. In addition, the SPS Jobs resource library includes expert career advice, document templates, and webinars geared toward helping the job seeker demonstrate his or her potential to hiring employers. In 2016, webinars include topics like “How to Give Outstanding Oral Presentations,” “How to Present a Winning Poster,” and “Women in Science and Engineering: Improving Your Chance for Success.” (Note: Both women and men will find the last workshop helpful and motivational in thinking about their own career advancement strategies and those of their colleagues.) Start building your career on SPS Jobs now!

SPS Jobs is part of the AIP Career Network, a collection of online job sites for scientists, engineers, and computing professionals. Other partners include *Physics Today*, the American Association of Physicists in Medicine (AAPM), American Association of Physics Teachers (AAPT), American Physical Society (APS), AVS Science and Technology, and the IEEE Computer Society. //

Explore your future in the physical sciences.



GradSchoolShopper.com



FOR MORE INFORMATION

Visit SPS Jobs, search for opportunities, and make a profile at <http://jobs.spsnational.org>.

Explore career resources at <http://jobs.spsnational.org/resources.cfm>.

Read about the experiences of other SPSers at www.spsnational.org/career-resources/currently-studying-physics.

Utilize the SPS Careers Toolbox, a set of tools and exercises designed to help undergraduate physics students prepare to enter the workforce, at www.spsnational.org/careertoolbox.



A service of

AIP American Institute of Physics



A Conference for Students, BY STUDENTS

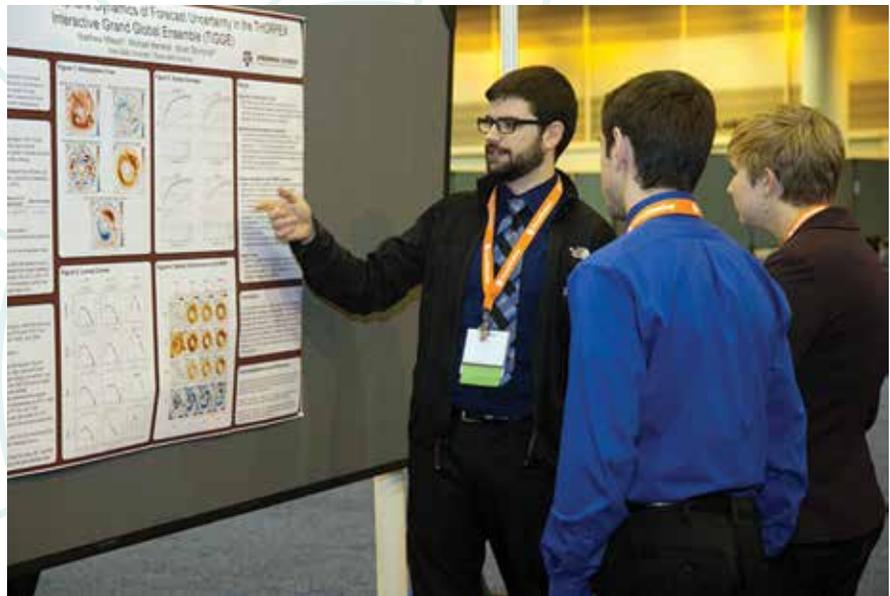
STUDENT VOLUNTEERS PLAN AMERICAN METEOROLOGICAL SOCIETY STUDENT CONFERENCE

by Josh Alland, graduate student at the University at Albany, State University of New York
 by Kristy Carter, graduate student at the University of South Carolina in Columbia
 by Aryeh Drager, graduate student at Colorado State University in Fort Collins
 Co-Chairs, AMS Student Conference

Meteorology can be an underappreciated career option for undergraduates in physics and related disciplines. Meteorologists aren't just forecasters, broadcasters, or academics; they span a diverse field with many different sectors and job opportunities.

As a student, a great way to get exposure to meteorology is to attend the American Meteorological Society (AMS) Student Conference. Intended for undergraduate and graduate students, the conference is organized by students who have attended the conference previously and want to give back to their fellow classmates and colleagues.

In January 2016, just before the 96th AMS Annual Meeting, over 700 students joined us in New Orleans for two jam-packed days of high-profile speakers and interactive sessions students wouldn't otherwise get to experience at their own colleges and universities. The conference featured a career and graduate school fair, a résumé workshop with direct feedback from professionals in the field, and an integrated warning team workshop where participants got to put themselves in the decision-making shoes of a broadcaster, forecaster, or emergency manager. It also featured panel sessions for attendees to explore different sectors of meteorology, plenty of networking activities where students could expand their professional circles and form new collaborations, and a poster session where students could share their research



MATTHEW MIKSCH OF IOWA STATE UNIVERSITY presents his research to attendees of the 15th Annual AMS Student Conference. Photo courtesy of AMS.

with professionals and each other.

As co-chairs of the AMS Student Conference, we and the rest of the AMS Student Conference Planning Committee spend much of our year creating the agenda and finding speakers across all sectors: severe storms, fire weather, tropical weather, instrumentation, satellites, clean energy, broadcasting, and everything in between! Planning a conference is a challenging, yet rewarding, experience. In working behind the scenes to put together the conference, we spend a lot of time talking with potential speakers, which helps build our own networks and allows for collabora-



tions and experiences we wouldn't have otherwise formed within our home institutions. Being part of the AMS Student Conference Planning Committee and attending the AMS Student Conference is a fantastic way to meet colleagues and make lifelong friends from around the globe. These relationships also enable us to help connect students to notable professionals in the field.

Individually, each of us has benefited from our attendance and experience with the AMS Student Conference.

Please consider joining AMS and attending a future AMS Student Conference. As our testimonials show, you have no idea where your career might end up. The professionals and students you meet at the conference could shape your future in ways you never would have expected. You never know—one day you might find yourself helping to plan a future conference for the next generation of students! //

Aryeh is nearing the completion of his M.S. in atmospheric science at Colorado State University:

"When I attended my first AMS Student Conference, I had just finished my undergraduate degree in engineering physics. The AMS Student Conference opened my eyes to the many different sectors and career paths within atmospheric science and meteorology, and it gave me a chance to ask questions and get advice from experts in fields that weren't well represented at my undergraduate institution. The understanding of the field that I got at the AMS Student Conference reinforced my decision to pursue graduate school and helped me understand how my field of interest, tropical meteorology, fit within the bigger picture."

Kristy is currently finishing up her M.S. in geography at the University of South Carolina:

"When I first attended the AMS Annual Meeting in January 2011, I was overwhelmed by the diversity of speakers and possible career paths. Continued attendance at the conference and increased involvement with the society has helped me navigate from my current research on snow and avalanches in southern Alaska to my next adventure, which will begin this summer. I'll be jumping into a co-major Ph.D. in meteorology and wind energy science, engineering, and policy at Iowa State University. 'Keep your options open and be daring enough to try something new.' This is something that was said to me at my first AMS Student Conference and now, six years later, I sit here thankful for the diverse set of skills developed while traversing through a multitude of meteorological sectors."

Josh is currently a Ph.D. student in atmospheric science at the University at Albany, State University of New York:

"I met my graduate school advisor while attending the AMS Student Conference in 2013 as an undergraduate. She was one of the speakers at the conference, and although I was shaking with nervousness when I handed her my résumé, she told me later, after applying to study with her in graduate school, that the interaction allowed her to put a face with the name on the graduate school application."

PROFESSIONALS CRITIQUE STUDENT RESUMES at the Student Conference Resume Workshop during the 15th Annual AMS Student Conference. Photo courtesy of Josh Alland.





ARE YOU READY?

THE PHYSCON PLANNING COMMITTEE AND SPS STAFF are pictured at X (formerly Google X) headquarters, where they discussed options for site visits during the 2016 Quadrennial Physics Congress. Photo courtesy of Richard Prince.

Big things have a way of happening in four-year cycles. The Olympics. The US presidential elections. And, as every SPS member knows: the Sigma Pi Sigma Quadrennial Physics Congress (PhysCon).

With only a few months remaining until the 2016 Congress, we're excited. And we hope you are too. Are you ready for a lineup of all-star speakers? Are you ready for workshops that immerse you in issues important to the physics community? Are you ready to make new, lifelong friends

from across the country?

As a taste of what's to come, we offer in this issue of *The SPS Observer* a preview of the science and technology site visits you can choose from at PhysCon. Thanks to the hard work of our planning committee, NASA's Ames Research Center will open its doors to you, as will Stanford's Linear Accelerator Center and the Google innovative experimental laboratory known simply as "X." Keep reading to learn more! //



GOOGLE SELF-DRIVING VEHICLE prototypes were embellished by local artists for a "Paint the Town" event in Austin, TX. Photo courtesy of Google.

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2016 Quadrennial Physics Congress

Four Things You'll Find At Google's "MOONSHOT FACTORY"

AND FOUR THINGS YOU WON'T!

by Rachel Kaufman

Housed in a former shopping mall a half mile from Google's main campus is a facility bursting at the seams with off-the-wall ideas. Employees skateboard and bike through the massive halls. There are dogs.

This is X (formerly Google X), the company's "Moonshot Factory," dedicated to solving really, really tough world problems with really, really crazy technology. Headed by Sergey Brin, the lab is working on four major projects today.

SELF-DRIVING CAR

By 2020, Google's self-driving cars will hit the market. That gives X engineers just four more years to perfect their prototype.

Prototype self-driving cars have already traveled more than a million miles without human help, the equivalent of 75 years of driving practice. The cars have tackled Lombard Street's hairpin turns, the Golden Gate Bridge, and Lake Tahoe.

There are still a few challenges to solve before they can be unleashed on the public, though. The cars haven't been tested in snow and can't tell the difference between a rock or a piece of paper, so they swerve to avoid both. They haven't quite figured out how to avoid pedestrians who are about to step into an intersection: one patent, granted to Google last fall, details ideas like an LCD screen that displays "coming through," a loudspeaker for verbal warnings, or even a robotic hand that would wave.

Each of the tiny, podlike cars has about \$150,000 in equipment inside, so you're not likely to see one as a personal vehicle right away—think taxis and shuttles first.

PROJECT LOON

Its name implies a touch of madness, but this idea may graduate from X as soon as later this year.

The effort to supply high-speed Internet to underserved areas by launching Internet-connected balloons into the stratosphere is being tested in Sri Lanka this year, following successful previous tests in New Zealand, California, and Brazil. India and Indonesia are reportedly interested.

ABOVE: The Project Loon team monitors their balloons 24 hours a day, from launch to recovery, and shares position information and projections with local aviation authorities. Photo courtesy of Project Loon / X.



AFTER MONTHS OF TESTING AND ITERATING, Google delivered the first real build of a prototype self-driving vehicle in December 2014. Photo courtesy of Google.



THE PROJECT LOON TEAM PREPARES solar panels, electronics, and balloon envelopes for launch as the sun rises in New Zealand. Photo courtesy of Project Loon / X.

In addition to the balloons, each as large as a tennis court with a lifespan of four months, Project Loon includes a device, nicknamed Chicken Little, that can fill and launch the balloons in 30 minutes each. The balloons communicate with each other in the air and shift altitude to catch winds that move them where they need to go.

MAKANI

Some places are more suitable for wind turbines than others. You need lots of land and wind that consistently blows—and neighbors who won't complain about the view and kill a project before it starts.

Enter Makani, which generates energy from wind using kites. Yep, you read that right. A specially designed kite in flight generates up to 600 kilowatts, sending the power back down through a tether to earth. That's enough to power over 100 homes.

Google purchased Makani Power in 2013 and rolled it into X that year. In late 2015, Google posted a number of open positions for Makani—including customer-facing positions like sales engineers—hinting that the prototype is soon to become a real product.

PROJECT WING

Move over, Amazon. Google's getting into the drone product delivery business.

Announced in 2014, Project Wing involves autonomous drones, developed by MIT roboticist Nick Roy, that Google says will be able to bring people their orders in just a minute or two. This will, according to X director Astro Teller, transform people's relationship to stuff. Why buy a drill that you use once a year or stockpile



THE 600KW ENERGY KITE IN THE MAKANI Team's test lot. Image courtesy of Makani / X.

batteries if you can rent the drill or buy batteries one at a time?

The technology behind the project has evolved significantly since it was first announced. The team originally developed a delivery system where the drone would lower packages to the ground via winch, but a recently granted patent describes "mobile delivery receptacles"—wheeled boxes on the ground that communicate with and guide the drones—that would accept a package from a drone and move it to a secure holding location.

There are still regulatory hurdles to overcome, but Google still says Project Wing could be making commercial package delivery by drone as early as 2017.

Those are the current four projects in development at X. Others have already "graduated"—like Google Glass—and others have been quietly killed after being deemed too out there. X tried to build a jetpack that proved too energy inefficient, and a tiny hoverboard that didn't scale up well to larger sizes. X also took a look at building a space elevator—rejected because of a lack of viable construction materials—and teleportation—rejected after concluding the idea violates the laws of physics. But, pointed out journalist Eric Mack in a 2014 article, even those discussions ended up leading to insights into new encryption technologies.

That's why X encourages ideas and solutions "that sound impossible today, almost like science fiction." Because you never know where asking the right question might take you. //



THE PROJECT WING TEAM is testing automated flight and delivery in rural California. Photo courtesy of Project Wing / X.

SLAC Probes Building BLOCKS OF MATTER

by Rachel Kaufman

Long before there was the Large Hadron Collider and the Relativistic Heavy Ion Collider, there was the Stanford Linear Accelerator.

When Stanford's particle collider opened in 1962, it was the longest linear accelerator ever built. It still is. The atom smasher has helped scientists make countless discoveries about the tiniest building blocks of our universe; three Nobel Prizes have been awarded for discoveries made, in part, by scientists working at SLAC.

"There's no end to the amazing things going on here," says Michael Peskin, a professor of theoretical physics at SLAC.

In 1957, particle accelerators at Brookhaven National Laboratory and the University of California, Berkeley, were leading the way in discoveries of new subatomic particles. Riding that wave, Stanford scientists proposed building an even more powerful collider. It would be 2 miles long and be able to accelerate electrons to 50 gigaelectronvolts, causing them to move much faster than any other accelerator of the day. It would also cost more than \$100 million in 1957 dollars, making it, at the time, the most expensive nondefense research venture in US history.

Still, researchers were confident that the proposed linear accelerator would provide answers for physicists, even if the answers were to questions that hadn't been asked yet. At one point during a congressional hearing, a senator asked one of the accelerator designers, Dr. Edward Ginzton, "Can you tell us precisely why you want to build this machine?" Dr. Ginzton replied, "Senator, if I knew the answer to that question, we would not be proposing to build this machine."

The collider eventually got built and almost immediately began producing solid science. In 1968, scientists working at SLAC discovered quarks for the first time. Just a few years



CONSTRUCTION OF THE ACCELERATOR TUNNEL

and experimental stations with the Interstate 280 overpass in the background, 1964. Photo courtesy of SLAC National Accelerator Laboratory.

later in 1974, SLAC's Burton Richter discovered the J/psi particle, as did another team at Brookhaven working independently. Just a year later a team led by Martin Perl discovered the tau lepton. These three discoveries would eventually lead to Nobel Prizes.

Around the same time, says Peskin, "Professor William Spicer noticed that the synchrotrons here emit X-rays at a rate which is...potentially a billion times more intense than one got from the standard equipment at the time. And so this enabled all kinds of new X-ray experiments, which were done here for the first time." The Linac Coherent Light Source, or LCLS, reuses a third of SLAC's old accelerator. (The other two-thirds is dedicated to the FACET project, which is an R&D project for experimental beam physics.)

Now, SLAC's X-ray free-electron laser "has pretty much taken over the whole laboratory," Peskin says. The LCLS,

TOP: This is an illustration of an electron beam traveling through a niobium cavity – a key component of SLAC's future LCLS-II X-ray laser. Kept at minus 456 degrees Fahrenheit, a temperature at which niobium conducts electricity without losses, these cavities will power a highly energetic electron beam that will create up to 1 million X-ray flashes per second – more than any other current or planned X-ray laser. Photo courtesy of SLAC National Accelerator Laboratory.

when it opened, was a billion times brighter than any other X-ray source in existence, says Alan Fry, division director of laser science and technology for the LCLS. "It's the difference between a high-powered laser and moonlight." The LCLS also produces extremely short pulses that last just a few femtoseconds. "This is the time scale on which stuff actually happens at the molecular and atomic scale," Fry says. That means researchers can use the LCLS to create essentially stop-motion movies of molecules breaking apart or electrons redistributing themselves.



ELECTRON BUNCHES FOR LCLS-II WILL GAIN ENERGY in niobium cavities like these. Cooled to extremely low temperature, these "superconducting" cavities allow radio frequency fields to boost electron energies practically without electrical resistance—a crucial property for the acceleration of electrons at a rate of up to a million bunches per second. Photo courtesy of R. Hahn/Fermilab.



SCIENTISTS HAVE MADE HIGH-RESOLUTION X-RAY laser images of an intact cellular structure much faster and more efficiently than ever possible before. Here a 20-sided structure from a bacterial cell, called a carboxysome, is struck by an X-ray pulse (purple) at SLAC's Linac Coherent Light Source. Image courtesy of SLAC National Accelerator Laboratory.

Mike Minitti, a SLAC scientist whose "molecular movie" of 1,3-cyclohexadiene unfurling was on the cover of *Physical Review Letters* last summer, told the journal at the time, "This fulfills a promise of LCLS. Before your eyes, a chemical reaction is occurring that has never been seen before in this way."

Because scientists are clamoring for time on the LCLS (SLAC runs around the clock almost every day), and because there's even more to be done with X-ray lasers, SLAC is building the LCLS-II, which will increase the number of X-ray pulses from 120 per second to a *million* per second. LCLS-II is under development now but won't open for another 5 or 6 years. When it does, researchers will be able to perform new kinds of experiments in emerging fields like quantum chemistry, structural biology, and surface physics, potentially leading to new understandings of basic matter, as well as new technologies and materials.

SLAC's equipment is used for more than just probing the properties of tiny particles. Scientists have studied the bone chemistry of Archaeopteryx with SLAC's synchrotron radiation lightsource and revealed hidden text written by Archimedes on a manuscript that had later been overwritten with 10th-century Greek Orthodox prayers. Other SLAC researchers are helping to develop an experiment that detects dark matter, or hunting for ways to improve rechargeable batteries, develop better antibiotics, and even improve computer hard drives.

"It's always been an exciting place, with people coming up with crazy ideas," Peskin says.

Fry agrees. "This is really only the beginning of the story of these machines and what they're going to be able to do and the science they're going to be able to produce." //



NOVEMBER REVOLUTION PUBLICITY PHOTO of Burton Richter, Martin Perl, and Gerson Goldhaber, standing in front of SLAC experimental equipment, 1974. Photo courtesy of SLAC National Accelerator Laboratory.

Beyond Planes at NASA's AMES RESEARCH CENTER

by Rachel Kaufman

Home to the largest wind tunnel on the planet, NASA's Ames Research Center has a rich history in aviation. It is also a contributor to nearly every NASA space mission, a pioneer in the field of nanotechnology, and a leader in astrobiology and synthetic biology.

One fan of the center is Mary Beth Wilhelm, a Ph.D. candidate at the Georgia Institute of Technology in Atlanta and a civil servant in the Planetary Science Branch at Ames. She is perhaps most known for her work on the landmark 2015 *Nature Geoscience* paper that found liquid water (very salty liquid water) on Mars. She's been working at Ames since she was 16.

"It was really amazing, as a high schooler when you're just learning what physics is, to be exposed to this extremely interdisciplinary field and learn from the world's experts on it," she says.

HISTORY OF AMES

Ames Research Center was founded December 20, 1939, as part of the National Advisory Committee for Aeronautics (NACA), an agency which was later folded into NASA. Charles Lindbergh helped choose the site for what was then called the Ames Aeronautical Laboratory; Moffett Field was already there, serving as a base for the Navy airship USS *Macon*. The facility's famous Hangar One, which NASA now owns and Google man-

CIRCA 1934 PHOTO OF HANGAR 1 with the dirigible U.S.S. *Macon*. Photo courtesy of NASA Ames Research Center.

ages, was built to house the *Macon*, a flying aircraft carrier that crashed off the coast of California in 1935. As the site already had runways, electricity, and was located near to the expertise of Stanford University scientists, it seemed like a good place to conduct flight research.

In the early days at Ames, research focused on



A 40-TON CRANE CAREFULLY LOWERS AN AIRCRAFT tail from the rafters down through the open doors of the tunnel's roof. Photo courtesy of NASA / Eric James.

engineering planes. Early airplanes had wings attached perpendicular to the plane's body, but at higher speeds, planes like that would become unstable. Ames researcher

Robert T. Jones was the first US aeronautical engineer to propose sweeping the wings backward, a design used on every high-speed aircraft to this day. (German engineers had been working on swept-wing designs for several years prior to Jones' discovery, but the information hadn't reached NACA.)

SPACEFLIGHT AND REENTRY

In the early 1950s, NACA headquarters asked Ames to study the "aerodynamic heating" problem, in preparation for sending craft into space. At the time, it was thought that the more streamlined a spacecraft or missile was, the better. But the military was running into problems with the ICBMs it was developing. Models showed that the shock wave in front of the nose cone could reach 12,000 degrees Fahrenheit, 2,000 degrees hotter than the surface of the sun. That would vaporize the warhead in seconds and put a serious damper on the idea of sending a human into



AN AERIAL PHOTOGRAPH OF NASA'S AMES RESEARCH CENTER taken in February 2012. Photo courtesy of NASA / Eric James.

space in a similarly shaped projectile.

Ames engineer Harry Julian Allen determined that a blunt-body vehicle—like the *Mercury*, *Gemini*, and *Apollo* capsules that were ultimately designed— would throw the heat away from the reentry vehicle. Ames researchers also developed and tested heat shields used in the space program.

Ames scientists also built one of the two clean rooms used to hold lunar samples from the Apollo program. (The other is at Johnson Space Center in Houston.)

POST-APOLLO

Though Ames is still a leader in wind tunnels and aerothermodynamics, it has moved beyond those fields to a broad range of other disciplines. Ames scientists helped found the field of computational fluid dynamics. They built many of the experiments the Viking rover took to Mars, invented aerogel used to collect dust from comets, and managed the Pioneer program, including Pioneer 10 and 11, the first human-made objects to leave the solar system.

Since 2009, Ames has been responsible for operating Kepler, the space telescope that has found over a thousand planets orbiting stars outside our own solar system. The center is becoming a leader in astrobiology and in engineering small, modular spacecraft (like CubeSats).

"Ames just has this sort of magic about it," says Wilhelm. "There's this really amazing culture that exists at Ames that I haven't encountered at any other NASA centers or other universities. It's a totally unique environment to work in." //

HANGAR 1 AT MOFFETT FIELD, Calif., 1992. Photo courtesy of NASA Ames Research Center.

2016 PhysCon ART CONTEST

ATTENDEES ARE INVITED TO SUBMIT 2- AND 3-D WORKS OF ART FOR JUDGING OR DISPLAY IN SIGMA PI SIGMA'S THIRD PHYSCON ART CONTEST.

ART CATEGORIES

- Congress Theme: Unifying Fields (mixed media)
- Congress Site Visits: Inspired by SLAC National Accelerator Laboratory, NASA Ames Research Center, and X (formerly Google X)
- General Science

Abstract deadlines and contest details can be found on the **PhysCon website at:**
www.sigmapi.org/congress/2016/art-contest.

Here we feature some of the winning pieces from the 2012 PhysCon Art Contest. To see larger images of all of the artwork, visit the PhysCon 2012 website at www.spscongress.org/physconprogram/artwork-contest. //



**FIRST PRIZE:
SPACE & GENERAL SCIENCE**
Water Droplet on a Blade of Grass,
by Lauren Dallachiesa, Grove City College



BEST IN SHOW
Pirouette, by Glenn Marsch, Grove City College



FIRST PRIZE: PHYSICS FOR EVERYONE

Daylight, by Natalia Guerrero,
Massachusetts Institute of Technology



**ARTISTS' CHOICE &
PEOPLE'S CHOICE**

Particle Detection in the Search
for New Matter, a collaboration by
Christopher Frye and Emily Daniels,
University of Central Florida



**FIRST PRIZE:
CONNECTING WORLDS**

Nothing Going on Here, or So
It Seems, by Jordan Guzman,
University of Central Florida

Images courtesy of the American Institute of Physics.

Have Breakfast with THE SCIENTISTS!

PHYSCON MEAL PROVIDES FOOD FOR THOUGHT

How often do you get the chance to sit down with a professional physicist you don't know over a plate of eggs and bacon? Breakfast with the Scientists, a special meal at PhysCon 2016, affords you this opportunity.

Meet professors outside your university. Chat with professionals outside of academia. We promise that it will be one of the highlights of your experiences at the congress.

But don't take our word for it. Listen to other SPS members who have taken part in the event at past congresses:

"One of the highlights of this experience was meeting Dr. Frederick Dylla, executive director of the American Institute of Physics. We had a chance to inquire about his work during breakfast. My encounter with the inspirational scientist left me in awe of how driven passion can manifest itself in substance. His backstory was an autobiography of ambition led by an unorthodox path. As I recall, he started conducting experiments at the age of 12, and one of his most intriguing experiments involved his fascination with lasers. His love for lasers had an immense ripple effect in his profession, which is reflected within his published work. Certainly his great success paid homage to his childhood love. The old adage must be true: 'Choose a job you love, and you'll never work a day in your life.'"

— JOEY HUA, BENEDICTINE UNIVERSITY

"Dr. Mahdi Sanati, associate professor at Texas Tech University, told his table that undergraduates should enjoy all of their undergraduate courses and not hastily sign up for research during the semester because a strong academic foundation must be established in the undergraduate years. He also advised students to be knowledgeable in multiple fields and not confined to one exclusively. In addition to the wisdom students could gain from the scientists, it was equally valuable to see the interest that the scientists took in the lives of the students. The breakfast tables provided a level field where everyone took an interest in discussing and learning science."

— MATTHEW GOSZEWSKI AND DAVID LEWIS, GROVE CITY COLLEGE

"Each of the scientists that participated was exceptionally involved and made it a priority to provide the students with useful and relatable information. During Breakfast with the Scientists, the undergraduate and graduate students ate at tables hosted by professional scientists, which opened us up to many career paths we had not considered. For example, as a result of this breakfast one of our members is now looking into the possibility of an internship with the US Federal Government."

— MARQUETTE UNIVERSITY SPS CHAPTER



BREAKFAST WITH THE SCIENTISTS is an opportunity for students to personally interact with professional physicists in small groups. Sometimes the only practicing physicists many students interact with are their professors, and this event affords them the opportunity to talk with scientists involved in careers outside academia. Participating scientists at PhysCon 2012 included (left to right, starting at top): Freeman Dyson (center), Shelly Arnold (center), John Mather (left), and Jocelyn Bell Burnell (second from right). Images courtesy of the American Institute of Physics.



2016 Quadrennial Physics Congress

REGISTER NOW FOR EARLY-BIRD RATES!

CONFIRMED SPEAKERS

- **Jocelyn Bell Burnell**, Visiting Professor at the University of Oxford
- **Eric Cornell**, Senior Scientist at JILA, NIST, and the Department of Physics, University of Colorado at Boulder, and 2001 Physics Nobel Laureate
- **Persis Drell**, Dean of Stanford University School of Engineering and Director Emerita of the SLAC National Accelerator Laboratory
- **S. James Gates**, Distinguished Professor and Director, Center for String & Particle Theory at the University of Maryland
- **Neil Turok**, 2016 Tate Medalist for International Leadership, South African physicist, and the Director of Perimeter Institute for Theoretical Physics
- **Patrick Brady**, Professor & Director, Center for Gravitation, Cosmology & Astrophysics at the University of Wisconsin, Milwaukee

WORKSHOP TOPICS

- Unifying Fields: Science Driving Innovation
- Careers for Physicists
- Communicating Science to the Public using Superheroes
- Taking your SPS Chapter to the Next Level
- Building up the Community
- Life as a Graduate Student

SCIENCE & TECHNOLOGY SITE VISITS

- SLAC National Accelerator Laboratory
- X (formerly Google X)
- NASA's Ames Research Center

TRAVEL ASSISTANCE

TRAVEL AWARDS

A limited number of Travel Awards in the amount of \$200 will be offered to help fund SPS members presenting their research at PhysCon 2016.

MSI and HBCU TRAVEL AWARDS

Through a grant from the National Science Foundation, funding for a limited number of full travel awards (registration, travel, and lodging) is available for students attending minority-serving institutions (MSIs) and historically black colleges and universities (HBCUs) to attend PhysCon 2016.

CHAPTER REPORTER AWARDS

A limited number of PhysCon Reporter Awards in the amount of \$600 will be offered to help fund SPS chapters who travel to and report about PhysCon 2016.

See website for award details and application procedures:
www.sigmapisigma.org/congress/2016

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Dr. Jocelyn Bell Burnell is the Honorary Chair of the 2016 Physics Congress. Best known for her pioneering work on the discovery of radio pulsars, Bell Burnell is a Dame Commander of the Order of the British Empire, Fellow of the Royal Society, and a Fellow of the Royal Astronomical Society. She was a plenary speaker at both the 2012 and 2004 Physics Congresses.



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Hosted by Sigma Pi Sigma, the physics honor society

Show & Tell in **Sunny Cali**

THE AMERICAN PHYSICAL SOCIETY FAR WEST SECTION MEETING
OCTOBER 30 & 31, 2015, IN LONG BEACH, CA

by Olivia Krohn
Class of 2017, California State University, Fresno

Imagine you have driven down the center of California for a few hours to arrive at the beautiful beaches of Southern California. Specifically, California State University, Long Beach.

Because you hit traffic on Interstate 5 (which every West Coaster knows is inevitable), the SPS welcome reception is already in full swing when you arrive. You and your classmate walk in, quickly grab a plate of finger food, and build up courage to join the small talk. The wonderful reality you discover is that everyone in the room has at least two things in common: we are all from the West Coast, and we all love physics. This, I learned, is a wonderful recipe for introductions and an all-around great evening.

This was the American Physical Society (APS) Far West Section Meeting. And it was fantastic.

There's nothing quite like meeting people with common interests, especially when physics tends to be one of the most difficult, smallest, but most rewarding interests you can have in common. Our commonalities made for good casual conversation, from the drought to REU experiences to favorite professors and their idiosyncrasies.

The next two days were even better, with invited talks spanning neutrino physics to alternative energy sources to cosmology. With a diversity of backgrounds, all the speakers had a passion for physics that was apparent in their excitement.

Each person seemed to have a unique yet universal draw to physics, something that contributed to a general camaraderie and shared excitement. Dr. Mu-Chun Chen from the University of California, Irvine, described how she chose physics over a potential career in music: "I wanted to just keep going and understand physics at the most fundamental level."

Dr. Michael Peterson from California State University, Long Beach, told me he was not interested in physics in high school but rather went to the University of Utah to study architecture. But when he took a physics class, "I fell in love with it," and he decided to switch to theoretical physics and math.

Also exciting were the talks by graduate and undergraduate students given on theoretical and experimental research being conducted on the West Coast. Research topics included

BELOW: Conference attendees enjoy an outdoor poster session. Photo courtesy of Olivia A. Krohn.



axions as dark matter candidates, mechanisms for determining neutrino mass, scattering, and many others.

My favorite part of the conference by far was the poster session, which struck me as not too different from a large-scale, epic session of show and tell.

Maybe it is more accurate to describe the session as what show and tell “wants to be when it grows up”—the real deal. It was a conglomer-

tion of ideas and glimpses into many different fields of study. It was better than a museum: not only was there something fascinating to learn, but there was a person personally attached to the research to talk to.

Wandering through the maze of posters allowed me to learn about a myriad of research projects by my peers—a potential lead on how to slow the onset of Alzheimer’s disease, studying plasma production by current-driven implosion, calibrating a telescope, analyzing preliminary results from CERN, and much more.

Why do 160 or so physicists and future physicists travel tens and hundreds of miles to listen to and give lectures? To ask and answer questions? I believe it is due to the inquisitive nature of physicists and the nature of the discipline itself: it is a search for knowledge and an enjoyment of sharing what has been learned.

Although not as large or epic as an April meeting, or so specialized and focused as a divisional meeting, this APS sectional meeting had a special charm in staying close to home. The diversity of interests and presentations was a source of inspiration, and the geographical familiarity a common ground.

Where else does “You’ve heard about this year’s Nobel Prize, right?” mix with “Can you believe we have already gotten an inch of rain this year?!” //

NEXT UP

The 2016 Annual Meeting of the APS Far West Section will take place October 28-29, at the University of California, Davis. For details, visit www.aps.org/units/cal/meetings/annual/index.cfm.



LEFT: SPS Reporter Olivia A. Krohn.

BELOW: Show & tell on a grand scale, physics edition. Photos courtesy of Olivia A. Krohn.





Supporting Women in Physics

THE AMERICAN PHYSICAL SOCIETY CONFERENCE FOR UNDERGRADUATE WOMEN IN PHYSICS (CUWiP) JANUARY 13–15, 2016, AT NINE LOCATIONS THROUGHOUT THE UNITED STATES

by Hannah Lewis
Class of 2016, St. Mary's College of Maryland

In my physics department only eight of the more than 35 physics majors and minors are female. So when I signed up to attend the Conference for Undergraduate Women in Physics (CUWiP), what intrigued me the most was the possibility of interacting with more women who get as excited about physics—and science in general—as I do.

The conference brings women together to discuss research, employment, and academic opportunities in physics, as well as to address some of the issues women in physics are confronted with throughout their careers. In the words of the American Physical Society, the most important aspect of CUWiP is to provide young women physicists with “access to other women in physics of all ages with whom they can share experiences, advice, and ideas.” I intend to con-

tinue on to graduate school this fall, so I was keen to meet women who might soon be my colleagues.

At a panel entitled “Careers in Physics,” we heard from four women: Rachel White, a high school teacher; Dr. Luminita Todor, a patent lawyer; Captain Austin DeLorme, an Air Force captain; and Dr. Sara Gamble, a government contractor. They spoke about careers in physics outside of academia. Each of the speakers explained their histories in science and gave words of encouragement to students seeking jobs beyond academia.

Two gave advice that truly stood out to me. When asked how she became the legal representative for large research departments, Dr. Todor said she’d “found her call.”

“A job is something that pays the bills,” she explained. “I hope that you find a ‘call.’ That is the supreme level of happiness to find.”



TOP AND MIDDLE: The meet and greet event at the Old Dominion University CUWiPs site.

BOTTOM: A professional skill panel with Dr. Susan Blessing, Tania Schindler (pictured), and Dr. Serena Dalena. Photos courtesy of the author.

Finding a career in physics is more than finding something to do to just get by. Captain DeLorme summed this point up nicely with: "I don't want to look back on my life and wonder what I did with it."

During a set of research and career talks, Dr. Christine Aidala, who is currently a professor at the University of Michigan, spoke about her physics timeline and about her current research into the strong force and the structure of the proton. In closing her talk, Dr. Aidala gave two pieces of advice. She told us that it is important to find a niche where you can make a meaningful scientific contribution. But in finding that niche, she stressed, it's important to realize that you have an infinite number of options. "Don't be afraid to change."

Soon afterward Ginger Kerrick, the national keynote speaker, was being projected into a lecture hall at Jefferson Lab, where I was, from the University of Texas. Kerrick is NASA's first female Hispanic flight director. She did not come upon the position easily. In my opinion, the most important thing that Kerrick said was, "Woman up." You can't let your background or your history keep you from pursuing what you want. It is your determination to succeed, as a woman, that will carry you throughout your life.

Following a poster session and dinner, Dr. Kathryn Flanagan, of the Space Telescope Science Institute, gave a talk appropriately named "Big Dreams – The James Webb Telescope and Beyond." She spent most of her time discussing the astronomical discoveries that might come from the JWST, or from an even larger telescope. As a woman who is incredibly accomplished in her personal and professional life, she was definitely an inspiration for those of us at the meeting, and for women physicists in general.

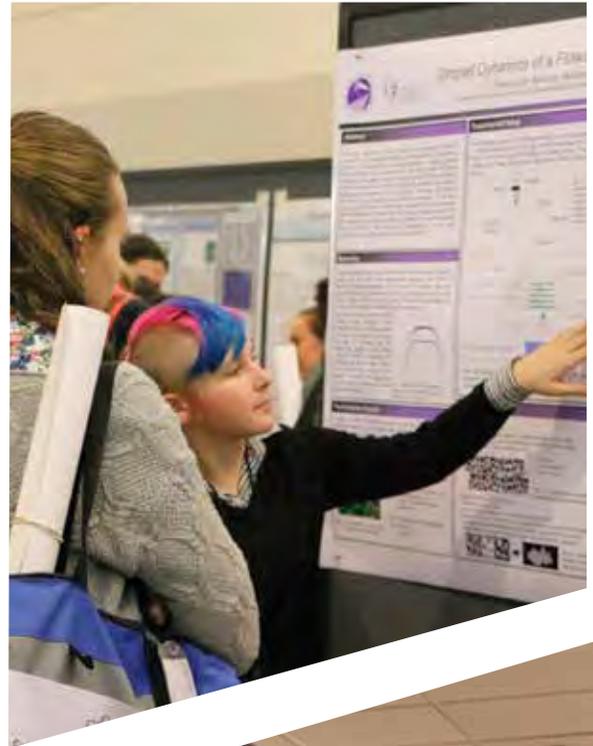
Then Dr. Arti Sarma, a clinical psychologist at Phoenix Veteran's Administration Hospital, talked to us about "CareerWISE," a workshop to teach resiliency and to encourage women who are pursuing doctorate-level education. The most important part about being a woman in science, according to Dr. Sarma, is to realize that "we've all been there." No matter what challenge you are facing, professional or personal, there is a community of other women scientists who are willing to help and support you when necessary.

Upon the close of the day, I felt that I had definitely bonded with the other physicists who had attended the conference. I already knew that I wasn't the only female in the physics community, but it was fantastic to interact with others who share experiences like mine. I know now that there is a strong, powerful community of female physicists willing to support me throughout my career. //

NEXT UP

The 2017 CUWiPs will take place January 13–15. For details and host institutions, visit the American Physical Society's website at www.aps.org/programs/women/workshops/cuwip.cfm.

BELOW & BOTTOM: Poster Sessions. Photos courtesy of the author.



ZONE 8 MEETING:

OKLAHOMA, KANSAS, AND MISSOURI
MEETING IN THE WOODS

BY SPS STAFF

When the SPS chapter at the University of Tennessee, Knoxville, signed up to host this year's Zone 8 meeting, they decided to try something different. Instead of gathering SPSers from other schools at their school, the chapter's leaders took everyone out to Cumberland Mountain State Park for a retreat.

Holding the event in the great outdoors proved economical, with attendees carpooling for travel and sleeping in affordable cabins. It gave a particular character to the gathering, as folks from across Tennessee and neighboring states toasted marshmallows on an open fire. And, perhaps most importantly, the fresh air proved to be the perfect setting for fun and getting to know each other—whether chatting about physics around camp or admiring nature during a group hike. //



IN MEMORIAM: JON LEVIN



On April 9 we lost a dedicated member of the Society of Physics Students (SPS) and Sigma Pi Sigma communities. We are saddened by the passing of our beloved colleague and friend, Dr. Jon Levin, professor of physics at the University of Tennessee, Knoxville (UTK).

Dr. Levin, the dedicated SPS Zone 8 councilor, was an outstanding and very generous member of Sigma Pi Sigma. He will be remembered for conducting countless outreach projects with his students and mentoring those with a curious mind for the physical sciences.

His love of teaching and compassion for his students earned him a 2015 nomination for the SPS Outstanding Chapter Advisor Award.

He was a friend to all and will be sorely missed. Read more about Dr. Levin's many accomplishments and contributions to the student and professional communities of physics and the physical sciences on the UTK website at <http://www.phys.utk.edu/news/2016/levin.html>.

The University of Tennessee has created a scholarship fund in Dr. Levin's memory. We, the SPS National Council and community, along with the American Institute of Physics, would like to give a gift to the scholarship on behalf of SPS and Sigma Pi Sigma. To add to the SPS/Sigma Pi Sigma contribution, please visit <https://donate.aip.org/jon-levin-memorial-scholarship> or mail your memorial gift to Sigma Pi Sigma: 1 Physics Ellipse, College Park, MD 20740. All checks should be made payable to Sigma Pi Sigma with a memo referencing the Jon C. Levin Scholarship.

Please join us in this farewell to an outstanding member of the physical sciences community.

ATTENDEES PRESENT POSTERS and participate in other activities at the Zone 8 meeting. Photos by Brandon Barker.

ZONE 11 MEETING:

IOWA, MINNESOTA, NEBRASKA, NORTH DAKOTA, AND SOUTH DAKOTA
TOP FIVE RECOMMENDATIONS FOR SPS CHAPTERS EVERYWHERE

By Lisa McDonald, Associate Zone Councilor, Zone 11
Class Of 2017, Coe College in Cedar Rapids, IA

Running an SPS chapter can feel like a very lonely task when the next closest chapter is hours away. This is the case for many of the chapters located in the Midwest SPS zones. Yet at least once a year these various chapters get to come together to share the hard work they've accomplished and spread successful ideas throughout the zone. This is exactly what happened for Zone 11 in March when the all-zone meeting occurred. Though small in terms of turnout, the opportunity for collaboration generated some really insightful recommendations for common concerns affecting SPS chapters everywhere. A list was created from all the ideas discussed, and it was narrowed down to these five tips. We hope you find them as helpful as we did.

#1 RECRUITING AND RETAINING MEMBERS

Every chapter wants to boost its membership. One way the South Dakota School of Mines and Technology (SDSM&T) does this is by holding their first SPS meeting of the semester during Advisor's Week, when freshmen come to meet with their advisors. This allows their chapter advisor to encourage freshmen to attend the meeting, and hopefully gain new members.

SPS members from the University of South Dakota (USD) and Coe College said they also advertise SPS during introductory physics courses, such as general physics and astronomy. You don't have to be a physics major to join SPS (did you know that?), and many nonscience majors take these classes to fulfill general education requirements. By advertising in these introductory courses, it provides the chance to involve more nonscience majors with SPS.

To retain members, SDSM&T runs a system where their involvement earns members points. They plan to allow those points to be exchanged for perks, such as money to attend a conference. While Coe does not have a point system, they also use conferences as a way to retain members. Newer members are given assistance to attend conferences at which older members are presenting, to learn the format of a conference and develop a goal that they, too, can strive for.

#2 ENERGIZING YOUR FUNDRAISING

Fundraising is critical to a chapter's survival. Every chapter that attended our Zone 11 meeting said it does campus fundraising by reaching out to university organizations such as Student Senate for a budget. Departments can also help fund club activities such as small, student-led projects selected during the beginning of the semester. Even if your university or department is small and cannot afford to support the chapter, the SPS National Office has many funding opportunities. These include starter kits, for example, Science Outreach Catalyst Kits (SOCKs), and awards for Student Reporters, Travel Awards, and Chapter Research. See the SPS National website for details: www.spsnational.org.

Internal chapter fundraising can also be effective. All chapters said they run a student lounge snack bar selling pop and candy bars. Coe has a student contest to design a T-shirt every year; shirts are then sold to students, faculty, and alumni. Coe's chapter uses its funds to sponsor membership fees for SPS National. Helping students pay for half the membership fee encourages more people to join, and once a student joins it commonly increases their involvement.



SPSERS VISIT the Sanford Underground Research Facility.
Photo courtesy of Lisa McDonald.

#3 BOOSTING YOUR PUBLIC IMAGE

Some of us use Facebook for our chapters. Some use Twitter. SDSM&T and Coe both use their university's websites to announce events, and Coe also has its own SPS website linked to from the university site. Each technique is effective in its own right, and other chapters are encouraged to experiment to find what works best for them. Coe also has an SPS member working as a news editor for the college paper. Encouraging someone to join the college paper not only provides publicity but gives that student a chance to improve their writing skills.

Don't neglect traditional promotional tools either. Posters work well to announce events. Some common areas also have television screens that can be hired to run advertisements to promote chapter events as well.



#4 IMPROVING YOUR PUBLIC RELATIONS

Connecting with your university's public relations office can help with access to venues for advertising on campus. Press officers can also help connect the chapter with the greater community by creating press releases to run in the city's media on events the chapter is hosting. Coe and SDSM&T have both used this to their advantage, and SDSM&T especially encourages reaching out for help from this office due to the success they've had with collaborations.

Coe's members volunteer as tutors for local high school students taking advanced physics classes, which connects the chapter to the community and helps to bring potential new students to Coe. SDSM&T members also volunteer in the community, for example, by weatherizing homes. USD hosted a science fair for local high school students which brought in over a hundred attendees.



#5 STRENGTHENING YOUR OUTREACH

We suggest new chapters without a large community presence plan outreach events for middle schoolers. Unlike younger students, they can appreciate the extent of science in society, and unlike older students, they often do not have set plans for future careers. SDSM&T and Coe both host physics conferences, known as Mines Day and Iowa Glass Conference, respectively. These conferences provide not only media attention in the community, but they also give members a chance to network with physicists from the larger science community.

Looking for outreach demo ideas? Here is a short list: Magdeburg hemispheres, slinky wave demonstration, nitrogen ice cream, dry-ice root beer, two forks and a quarter demonstrating center of gravity, magnetic levitation with a copper plate, phantom crystals, infinity mirrors, and UFO balls.

We felt these suggestions would help everyone strengthen their individual chapters throughout our zone. We hope they can help you as well. And we hope to see you at PhysCon! //



TOP: Zone meeting attendees pause for a group photo at their Saturday dinner.

MIDDLE: SPSers take a tour of SDSM&T's particle astrophysics research center.

BOTTOM: Visitors take a break from science to enjoy the view. Photos courtesy of Lisa McDonald.

FIND A ZONE MEETING

Interested in attending a zone meeting? Check out the SPS calendar for information about upcoming zone meetings, www.spsnational.org/meetings/zone-meetings.

LET'S GET TO PHYSCON!



The national office of the Society of Physics Students and Sigma Pi Sigma has fundraising kits for your local chapter that can help finance your attendance at PhysCon 2016, held November 3-5 in Silicon Valley, CA.



2016 Quadrennial Physics Congress



Order your free kit today by going to this web page:
sigmapisigma.org/congress/2016/physcon-fundraising-kits