

# the SPS Observer

Volume LI, Issue 1

SPRING 2017

## Doing RESEARCH

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Lab safety glasses in an astronomical laboratory at Texas A&M University. See "Laboratory Safety is a Critical Component," on p. 17.



**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.

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### 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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# Reflections on the Society of Physics Students

by DJ Wagner, Outgoing President of the Society of Physics Students

Nearly 30 years ago I said “Sure,” when a classmate invited me to an SPS meeting. That simple response opened doors to a host of opportunities that continue to this day. As an undergraduate student, I participated in outreach events that are among the most vivid of my college memories and presented my research at a national conference. As a professor, I have supported several SPS chapters and mentored many SPS members. And, as an advisor of two chapters, I have encouraged students to become involved in outreach and attend professional meetings. Through taking students to professional meetings, I found out about the SPS National Council and was encouraged to run for election. Now, as a member of the National Council, I have had the privilege to help guide the society while meeting and working with countless numbers of incredibly talented and dedicated students and faculty from around the world. These opportunities have all occurred because someone asked me to a meeting in 1988.

When I reflect on SPS, several themes arise: community, professional development, and diversity.

SPS is, above all else, a community of individuals interested in physics. I ultimately attribute my 30 years of SPS involvement not to my saying “Sure,” but to my classmate asking me to the meeting. Someone reached out to me personally and made me feel that my presence was desired.

Yet invitations are just the beginning of building a robust community. When someone arrives at your meeting or event, is that person welcomed? Do you mentor underclassmen and encourage them when they struggle? Is the atmosphere of your meetings and meeting space such that all attendees (and potential attendees) feel comfortable and included? Do you reach out to every-



**SOCIETY OF PHYSICS STUDENTS PRESIDENT 2013-2017 DJ Wagner (left).** Photo courtesy of DJ Wagner.

one interested in physics, not just physics majors or people who seem similar to yourself? I encourage each of you to think deeply about how to strengthen and expand your chapter’s community, and to spend chapter meeting time soliciting and discussing ideas.

In addition to enriching your community, SPS also does an exceptional job supporting your professional development. In a previous *Observer* article, I described the benefits of professional society membership and of attending professional meetings. SPS not only provides funding for students to attend national meetings of the AIP Member Societies, it hosts many student-centered meetings: Zone meetings and PhysCon. I first attended a PhysCon in 2004—it was the most incredible conference I had ever attended. The mix of high-profile speakers and interactive workshops at what is now the largest assembly of undergraduate physics students in the world is unparalleled. Your chapter should start now to fundraise and promote PhysCon 2019 in Providence, RI. Contact your zone councilor or associate zone councilor for fundraising or promotional help.

SPS provides a plethora of career resources. The Careers Toolbox ([www.spsnational.org/careerstoobox](http://www.spsnational.org/careerstoobox)) contains useful information and exercises to help prepare for your career, such as tips on

how to update your resume and information on the job market. The SPS Jobs site (<http://jobs.spsnational.org/>) provides job postings tailored for SPS members, along with profiles of physicists pursuing diverse careers. You should check out the Features and related Department articles within this issue for tools to support your development as a researcher and independent thinker.

Finally, the Society of Physics Students is very diverse, not just because we advertise that “Physics is for Everyone” and have a strong history of promoting inclusive practices, but also because each chapter is unique, with its own character and structure. SPS embraces those differences and provides resources and “best practice” advice for chapters of all types. Ultimately, you have to find what works for your chapter—look to SPS for ideas. And don’t forget to apply for travel, outreach, and research awards, scholarships, and internships!

While it is time for me to cycle off the National Council, my connection with SPS will continue. I have no doubt that the next 30 years of my SPS experience will be just as rewarding as the last 30, and I cannot wait to see the continued growth and strengthening of this outstanding organization. I hope you find your SPS experience just as rewarding! //

# What to Expect at Your Summer Research Experience

by Rachel Kaufman, Contributing Writer

**Congratulations on landing a summer research position. Research Experiences for Undergraduates (REUs) and other summer research experiences are not just great fun but also important resume builders and a great way to expand your network of peers in the physics community.**

If you've never done anything like this before, don't worry! The professors you're working with want you to succeed.

There is another advocate in your corner: Kiril Streletzky, the zone councilor for Zone 7 and a physics professor at Cleveland State University (CSU) who organizes (along with co-PI Jessica Bickel) a REU at the school. We spoke to Kiril about ways to make the most out of your 10 weeks.

**Observer:** What do students need to do to prepare before they even start their REU?

**Streletzky:** The first thing they need to figure out is which project they're going to be working on. Sometimes students need to double-check this. Ideally, they should know what they are getting into before they arrive, but they should be proactive and find out for themselves. Get in touch with the project leader. Ask, "What would you advise me to read up on, and do you have a specific thing you want me to start looking at?" REUs are only 10 weeks. It makes sense for students to be familiar with the project before they come. It's full-time employment for 10 weeks, but still.

**Observer:** Is that an adjustment for students, going from classroom to essentially full-time work?

**Streletzky:** I suspect it might be, and not necessarily because of the hours but because of the intensity. In addition to work in the lab, the students have seminars, colloquia, lectures, field trips. It's a very

busy schedule. At the REU at CSU, it's basically something every day.

**Observer:** OK. What's important for students to do during week one?

**Streletzky:** Students need to not be afraid of questions. They need to get to know the other students in the program, the program coordinator, and the administrative staff, figuring out who are the people to contact. And, of course, getting to know the advisor as well.

**Observer:** Are there norms at an REU that might come as a surprise for undergraduates? Is, say, attire different in a lab than in a classroom?

**Streletzky:** Attire is not a problem, except for formal presentation days. Students usually will have to present their project to the rest of the REU community, and usually there will be a poster session or symposium. I was judging posters at the APS March Meeting and a few kids had no idea how to dress up for a poster session. So an REU will give you a chance to learn that maybe you shouldn't be barefoot.

**Observer:** What else should students expect as far as the "work" world goes?

**Streletzky:** Being flexible is one important thing. Maybe some days you will have to work in the lab more than eight hours, but on other days you don't have to do as much. It makes sense to live on campus...so you are close to your lab space, and then it's not a problem to stay later one day.

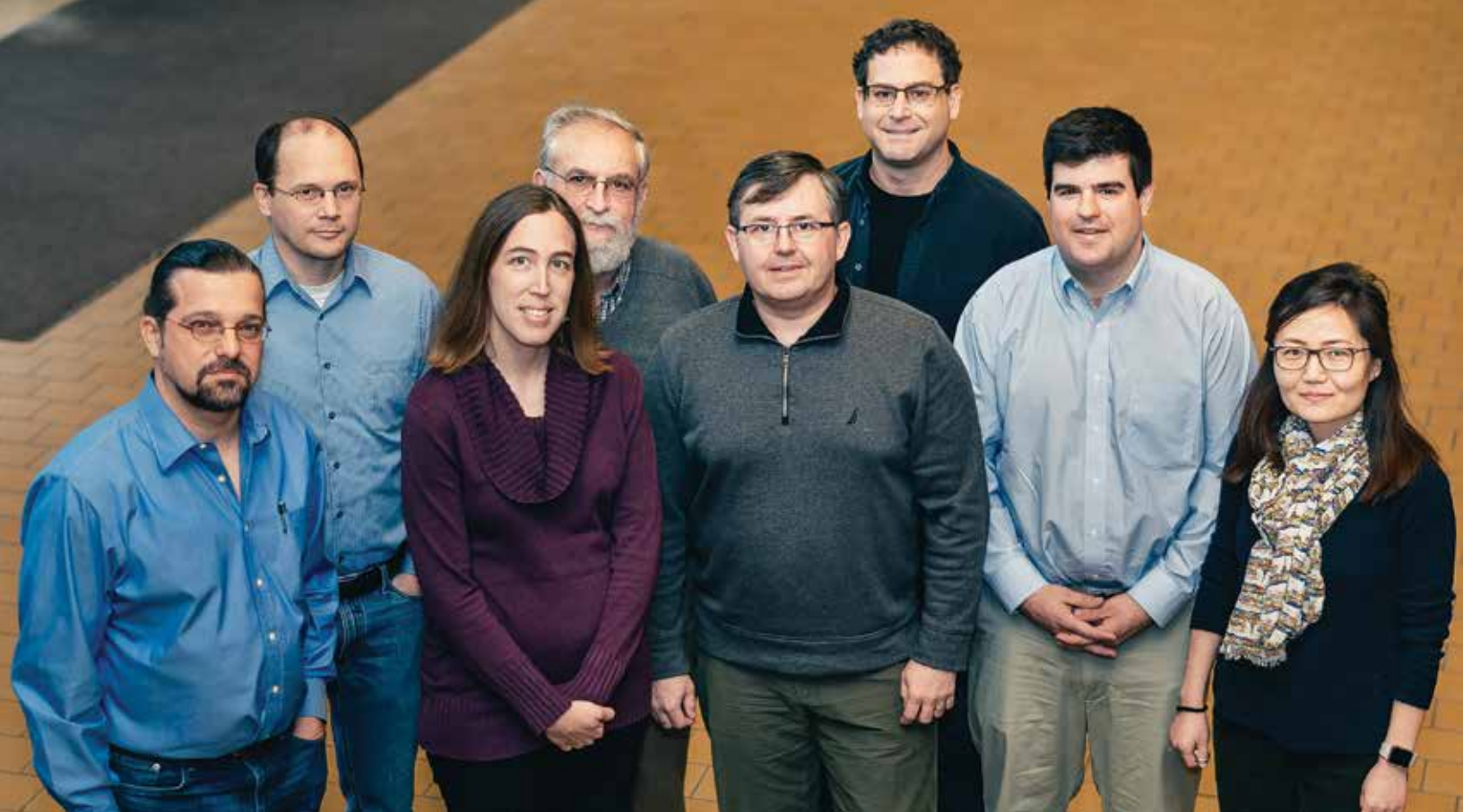
On the other hand, one important idea of REUs is to build a community. It depends on the program...in other programs they have a number of mandated social activities. They want to make sure you are not sitting in your room in the off hours. They want you to network.

**Observer:** Should you prioritize connecting with peers, then?

**Streletzky:** In some sense, peers in an REU will understand you better because they're going through similar issues. Two students worked in my lab during the school year and went to an REU at another university. They built networks there, they met students there. They brought







**PICTURED LEFT TO RIGHT:** Dr. Kiril Streletzky (PI), Dr. Nolan Holland, Dr. Jessica Bickel (co-PI), Dr. Miron Kaufman, Dr. Petru Fodor, Dr. Andrew Resnick, Dr. Chris Wirth, Dr. Geyou Ao, Not Pictured: Dr. Chandra Kothpalli. Participating faculty of the Softmatter REU at Cleveland State University. Photo courtesy Dr. Kiril Streletzky.

**LEFT:** Dr. Kiril Streletzky and SPS Member, Karen Johnson, align a laser beam at Cleveland State University's Light Scattering Spectroscopy Lab. Photo courtesy Dr. Kiril Streletzky.

back ideas for collaborations with me. They spent a summer there, they came back, and continued on the same project for... two years.

**Observer:** What should you do in your final week?

**Streletzky:** Don't work on the project until the very end. Make sure that whatever you have done has a very good record. Ten weeks is a short time, and rarely is it possible to complete something publishable as a paper, but it's extremely important for students...to have a good record of what has been done. They might not pay attention to the results during the summer, but later on they will likely come back to this. There might be a paper hiding in there that they didn't realize at the time of the REU.

The last week, in my mind, is wrapping up and making sure that none of what has been done is lost. Very often it happens that you have this excitement—you're trying to get more data and more analysis and you're working up to the last moment getting new stuff, but then you leave to a different part of the country. You forget about it, your advisor forgets about it.

**Observer:** For readers who did not land an REU this summer, how should they prepare for the next round of REU applications?

**Streletzky:** Try to land some sort of research-related opportunity this coming summer. Maybe a research project for credit. That is usually something that helps you stand out as a candidate. You can see that students are serious about research.

Also work on building your network. Not all REUs and other research experiences are advertised on job sites like through the National Science Foundation (<https://www.nsf.gov/>), or SPS Jobs (<http://jobs.spsnational.org/>) or a job site. Making connections will let you find these REUs before they are posted. Having decent grades helps, too.

**Observer:** Any final thoughts on what students should expect?

**Streletzky:** They should expect the time of their lives, really. It's an exciting experience to get. And to get to know professors who will be working with you. That's a big step. Those professors are the lead letter writers for graduate school and potential jobs. It's one thing to get a letter of recommendation from a professor who taught you in a course. It's a completely different thing to get a letter from a professor you worked with or presented with. //

# My Experience as a Fresh Intern in a New City

by Vanessa B. Espinoza, SPS Member, Texas Lutheran University

**I never would have guessed that I would find my home away from home in the heart of our country's capital. I've never been the type to leave Texas for more than a few weeks of vacation, but the experience that I gained while living in DC was one that will impact me forever.**

As the second half of my junior year was flying by, I was searching high and low for all the physics summer research experience information that I could get my hands on. Every professor raves about summer research experiences and how helpful they can be to discover where one's passions lie. As an active member of the Society of Physics Students, I knew that the SPS internship program existed but figured the odds of me getting to work at NIST (National Institute of Standards and Technology) were slim to none. Nonetheless, I decided to apply and take a chance. To my surprise, I was chosen as one of the two students who would make the Metro ride to NIST everyday!

My journey from San Antonio, Texas, to Washington, DC, meant culture shock and a realization of how much walking I would be doing. I will never forget my first trip to the grocery store. After getting lost and walking an extra mile I finally arrived with a large tote and a long list. Forgetting that there wasn't a car to load all of my groceries into, I piled all of my groceries into the basket and then ended up walking out of the store with my full tote and six other bags hanging from my arms. The one and a half mile walk back was not an experience I would like to repeat, but it certainly is fun to laugh about it now. Obviously, I quickly adjusted and found closer stores.

Living in DC was amazing. There was always something free to do, the food was much more diverse than my usual tacos, and my roommates and I became friends who I will never forget.

The experience at NIST was one of the most amazing any young scientist can have. They work on practically everything, and one of the really great bonuses is that you can listen to a variety of lectures at almost any time of the day to learn about what other scientists are working on across its huge campus. I had the opportunity to work with one of the brightest and most kind-hearted physicists in the physical measurements laboratory. Dr. Angela Hight Walker is a physicist—more specifically, a spectroscopist—who works heavily with Raman spectroscopy.



**TOP:** Pictured left to right: Dr. Angela Hight Walker, Vanessa Espinoza, Dr. Erin Wood.

**BOTTOM:** Vanessa Espinoza using the spectrometer.  
Photos courtesy Vanessa Espinoza.

I came from a small university, and one of the most rewarding experiences I encountered was the opportunity to work with abundant instrumentation. This experience heightened my love for research and solidified my desire to pursue a graduate degree. I feel like I learned so much that will remain helpful in any career I pursue. For any young student who is trying to figure out if they are willing to go out on a limb and apply for this summer internship, my advice is to apply. The hour or so that you spend applying for this summer internship—or any of the hundred others that are available—may seem like a lot of time in that instance, but the payoff is worth the work. Aside from the awesome science you will get to do, you will also make friends and memories that will last a lifetime! //



# Finding Connections:

## SPS Student Recognized for Photonics Research and Leadership

by Nick Rivera, SPS Member, Massachusetts Institute of Technology and Kendra Redmond, Contributing Writer

**The American Physical Society's LeRoy Apker Award recognizes outstanding achievements in physics by undergraduate students and provides encouragement to young physicists who have demonstrated great potential for future scientific accomplishment. The 2016 recipients are Stephanie Gorczyca from the University of San Diego and Nick Rivera from Massachusetts Institute of Technology (MIT).**

**Below, we hear from SPS member Nick Rivera on his research, SPS involvement, and what this award means to him. His Apker Award citation reads: "For important advances in the field of photonics and exceptional leadership of the Society of Physics Students."**

What happens when excited atoms interact with the quantum vacuum fluctuations of electromagnetic fields of 2D conductors (like graphene)?

This was the focus of my undergraduate thesis work at MIT. The short answer: Potentially, a lot.

Spontaneous emission processes in atoms that normally take billions of years to happen could potentially take place in billionths of a second when an atom is placed a few nanometers away from the surface of graphene. Such a spontaneous emission process has not been observed, but my work suggests a general recipe for accessing these kinds of rare processes, possibly providing a spectroscopy platform that could access a much more detailed optical fingerprint of any atom or molecule. I was the first author of a paper on this research that was featured in the journal *Science* in July 2016 (DOI: 10.1126/science.aaf6308), and it was the subject of my Apker Award presentation.

I am now a first-year physics PhD student at MIT working under Prof. Marin Soljacic on problems in light-matter interaction and nanophotonics. This research flowed naturally from my undergraduate research and can be divided into two basic goals. The first is enabling, accessing, and controlling conventionally forbidden atom-photon interactions. The second is studying fundamental electron-photon interactions in order to find new ways to generate high-frequency light on the nanoscale and to enhance quantum mechanical effects in electron-photon interactions.

What unifies these two parts is analysis through the tools of classical and quantum electrodynamics and through the lens of nanophotonics, the science of controlling the properties of photons on the nanometer scale. More generally, my interest is in taking tools from what is normally considered "theoretical" physics and using them to analyze problems of a more applied nature.

As the vice president and president of my local SPS chapter, I aimed to bring student research to the forefront. To that end, I introduced a new event called SCUPH (Student Colloquia in Undergraduate Physics), where undergraduates give research talks that are open for anyone to attend. My hope in developing this event is that undergraduate physics students will be



**NICK RIVERA.** Photo courtesy of the U.S. Department of Energy.

exposed to approaches to physics beyond what they are familiar with from their own research.

Receiving the Apker Award was a great honor. I am grateful for not only the physics contributions of my collaborators, but also the mentorship and attention I received from the graduate students, postdocs, and faculty that I worked with. They ultimately shaped my thinking on how to approach physics and challenged me to be creative and imaginative. Because of them, I identify the fun in physics research as the process of finding new connections between seemingly unrelated physical ideas. //

**For more information on the LeRoy Apker Award, visit the APS website at [www.aps.org/programs/honors/awards/apker.cfm](http://www.aps.org/programs/honors/awards/apker.cfm).**

# Fall 2016 Chapter Awards

Congratulations to the following winners of the Fall 2016 Chapter Awards. These awards are made possible in part by generous contributions from Sigma Pi Sigma alumni. For examples of past award-winning projects, visit [www.spsnational.org/awards/chapter-awards](http://www.spsnational.org/awards/chapter-awards).

## FUTURE FACES OF PHYSICS

Future Faces of Physics Awards are made to SPS chapters to support projects designed to promote physics across cultures. The goal of the Future Faces of Physics Award is to promote the recruitment and retention of people from groups historically underrepresented in physics.

### California State University, San Marcos

CSUSM Society for Diversity in Physics  
Josefa Gregorio (Leader)  
Justin Perron (Advisor)

### Colorado School of Mines

Future Faces of Physics with CSM SPS  
Nicklaus Smith (Leader)  
Chuck Stone (Advisor)

### Green River College

Energy: Harnessing the Power of Nature  
Alyssa Leano (Leader)  
Ajay Narayanan (Advisor)

### Metropolitan State University

Be a Scientist Day  
Michael Roos (Leader)  
Jeff Loats (Advisor)

### Rhodes College

Smashing Stereotypes: Egg Drop for  
Memphis Girls  
Eleanor Hook (Leader)  
Brent Hoffmeister (Advisor)

### University of the Sciences

"Turn"ing Up with Physics  
Despina Nakos (Leader)  
Roberto Ramos (Advisor)

## MARSH WHITE

Marsh W. White Awards are made to SPS chapters to support projects designed to promote interest in physics among students and the general public. The Marsh W. White Award dates back to 1975 and is named in honor of Dr. Marsh W. White for his long years of service to Sigma Pi Sigma.

### Abilene Christian University

Jazz Gluon Fusion  
Hannah Hamilton (Leader)  
Tim Head (Advisor)

### Adelphi University

Lab for Kids  
Tara Pena (Leader)  
Matthew Wright (Advisor)

### Appalachian State University

Edible Laser  
Jack Griffin (Leader)  
Brooke Hester (Advisor)

### Cleveland State University

Sounds and the Sources Around Us  
Samantha Tietjen (Leader)  
Kiril Strelitzky (Advisor)

### Lamar University

Engaging Our Youth: Raising High  
School Students' Interest in Physics  
through Thought Provoking and  
Interactive Demos  
Carlos Caballero (Leader)  
Christian Bahrim (Advisor)

### New Mexico State University

Demonstrating the "Phun" Side of  
Physics through Hands-On Projects  
Ashley Allred (Leader)  
Boris Kiefer (Advisor)

### Rensselaer Polytechnic Institute

Bridge the Gap Initiative  
Rachel Maizel (Leader)  
Gyorgy Korniss (Advisor)

### Towson University

Science After Hours  
Emileigh Shoemaker (Leader)  
Parviz Ghavamia (Advisor)

### University of Central Arkansas

Demo Show Series Inspired by the Next  
Generation Science Standards (NGSS)  
Charles Bertman (Leader)  
William Sloan (Advisor)

### University of Southern Mississippi

Promoting Physics to the Community  
Andrew Giovengo (Leader)  
Michael Vera (Advisor)

### University of the Sciences

Catch That Wave: The Physics of Waves  
Katee O'Malley (Leader)  
Roberto Ramos (Advisor)



## SPS CHAPTER RESEARCH

The SPS Chapter Research Award program provides calendar year grants to support local chapter activities that are deemed imaginative and likely to contribute to the strengthening of the SPS program.

### U.S. Air Force Academy

Collisional Processes in Alkali-Buffer Gas Systems for Alkali Laser Development  
Jeremiah Wells (Leader)  
Alina Gearba (Advisor)

### Cleveland State University

Deducing Size and Shape of Gold Nanorods in Solution from Depolarized Dynamic Light Scattering Data  
Ilona Tsuper (Leader)  
Kiril Streletzky (Advisor)

### Loyola Marymount University

Quantum Droplets: Pilot Wave Phenomena  
Luciano Manfredi (Leader)  
David Berube (Advisor)

### Northern Virginia Community College

Atmospheric Muons as a Probe for the Higgs Vacuum Energy and of the Lead Stopping Power  
Cioli Barazandeh (Leader)  
Walerian Majewski (Advisor)

### Southeast Missouri State University

Hybrid Photo-Magnetic Actuation for Target-Specific Killing of Damaged Cells  
Varun Sadaphal (Leader)  
Jonathan Kessler (Advisor)

### Texas Lutheran University

Thermal Imaging to Determine Heat Loss from Structures on TLU Campus  
Daniel Morales (Leader)  
Toni Sauncy (Advisor)

### University of Kansas

KUbeSat Primary Cosmic Ray Detector  
Billie Lubis (Leader)  
Dave Besson (Advisor)

### William Jewell College

Shaping Analysis of Magnetic Fluids  
Denver Strong (Leader)  
Blane Baker (Advisor)



**RHODES COLLEGE SPS OUTREACH OFFICER**, Eleanor Hook, provides students tips on experimental technique at a local Memphis high school as part of their Future Faces of Physics project. Photo courtesy of Eleanor Hook.

## SIGMA PI SIGMA CHAPTER PROJECT

The Sigma Pi Sigma Chapter Project Award provides funding of up to \$500 for chapter inductions and events.

### St. John's University

Sigma Pi Sigma Induction Ceremony  
Rachel Tyo (Leader)  
Charles Fortman (Advisor)

### University of the Sciences

Reviving the Sigma Pi Sigma Physics Honor Chapter at the University of the Sciences  
Roberto Ramos (Leader)  
Roberto Ramos (Advisor)



# Atmospheric Muon Lifetime, Standard Model of Particles, and the Lead Stopping Power for Muons

by Cioli Barazandeh, SPS Member, Northern Virginia Community College

**The SPS chapter at the Northern Virginia Community College, Annandale, Virginia, was created in 1990 and since then has been mentored by the SPS advisor, Professor Walerian Majewski. Year after year, the chapter centers its activity not just on educating its members, but also on outreach to the physics community and beyond, to show that freshmen and sophomores can do physics research.**

Our new project uses a scintillator to track muons and find the lifetime of the muon at rest, as well as calculate the lead stopping power for muons. These are not new contributions to the field of particle physics, but we want to prove that undergraduates at a community college can do serious, ambitious research.

Also, our experimental design is different than other experiments that have made these measurements because we have only one muon detector. Usually stopping power is measured with two or more detectors.

Our scintillation detector was donated by the Thomas Jefferson National Accelerator Facility in Newport News, Virginia, where our advisor has friendly colleagues. An SPS research grant last year got us the money we needed to buy lead plates and bars. Since muons are accelerated to earth by cosmic rays, we don't need an accelerator—we get our particles for free!

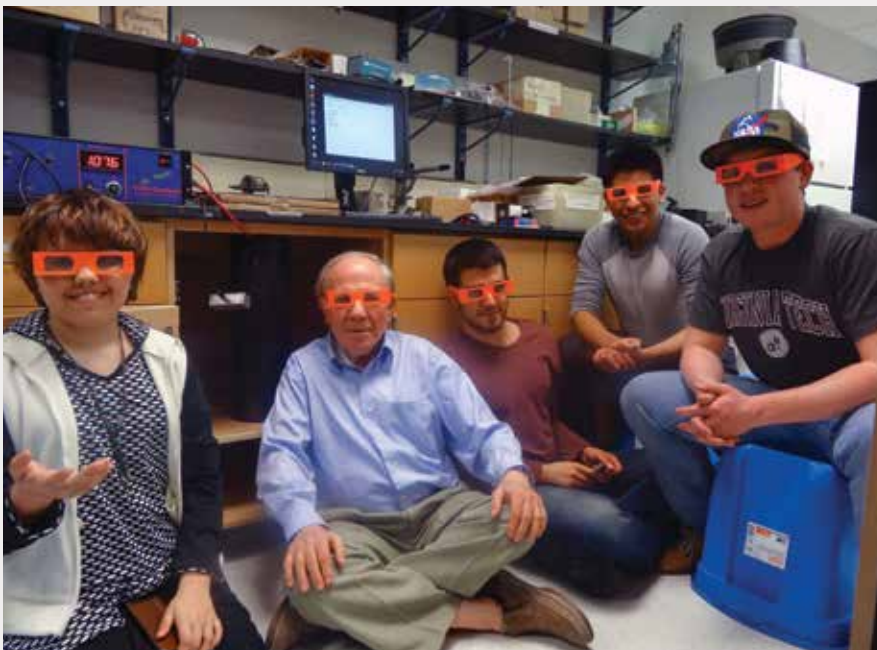
The muon, an unstable lepton particle, is effectively a massive version of the electron. What makes it especially of note for the experiment is that it has

the longest free-particle lifetime. Muons are present in the secondary cosmic ray showers in the atmosphere and are one of the few particles to reach sea level. They decay into three other leptons, which are an electron and two neutrinos (which in our experiment escape undetected). The muon detector registers arrival and stopping of a muon as a voltage pulse, which originated from its plastic scintillator, and may detect, after the time delay of about 2 microseconds, an appearance of the second pulse, which occurs from the electron created in the decay. The distribution of the individual muons' lifetimes can be averaged in order to find the average muon lifetime at rest.

From this measured lifetime, the weak nuclear charge  $g_w$ , which is an analog of the electric charge, can be calculated in terms of the known mass of the muon and the W-boson. Using another standard model relationship, which is dictated by the known unification formulas of the weak and electric forces into a single electroweak force, we can find from our muon lifetime—a totally nonelectric experiment—the value of the elementary electric charge  $e$  and so, the strength of the electromagnetic charge of  $e$ . This turns out to be a number close to the value  $1.6 \times 10^{-19} \text{ C}$  we see in our introductory physics textbooks.

In our experiment, we will also determine the sea-level fluxes of muons. After shielding the detector with varying thicknesses of lead plates and bricks, from the new attenuated values of fluxes we can find the muon stopping power for lead, which shows how muons ionize the lead atoms in their passage through lead. Our detector permits us to measure separately properties of low-energy muons (below 150 MeV of kinetic energy) and of the high-energy muons, which on average have 4 GeV of energy.

Recently the results of the chapter's previous muon experiments were published



**PICTURED LEFT TO RIGHT:** Cioli Barazandeh, Dr. Walerian Majewski, Sepehr Samiei, Jorge Del Carpio Arispe, and Brady Murphy, student SPS members and advisor of Northern Virginia Community College. Photo courtesy of Dr. Walerian Majewski.

in the Journal of Physics Conference Series<sup>1</sup> and in Presentations at the American Physical Society's meeting in January 2017.<sup>2</sup>

Usually when we present at conferences, we are the only community college presenting physics research. But we would like to see other community colleges performing research like this.

This experiment is one example of research in elementary particles that is accessible to early undergraduate students from community colleges. We hope that other community colleges will follow our lead.

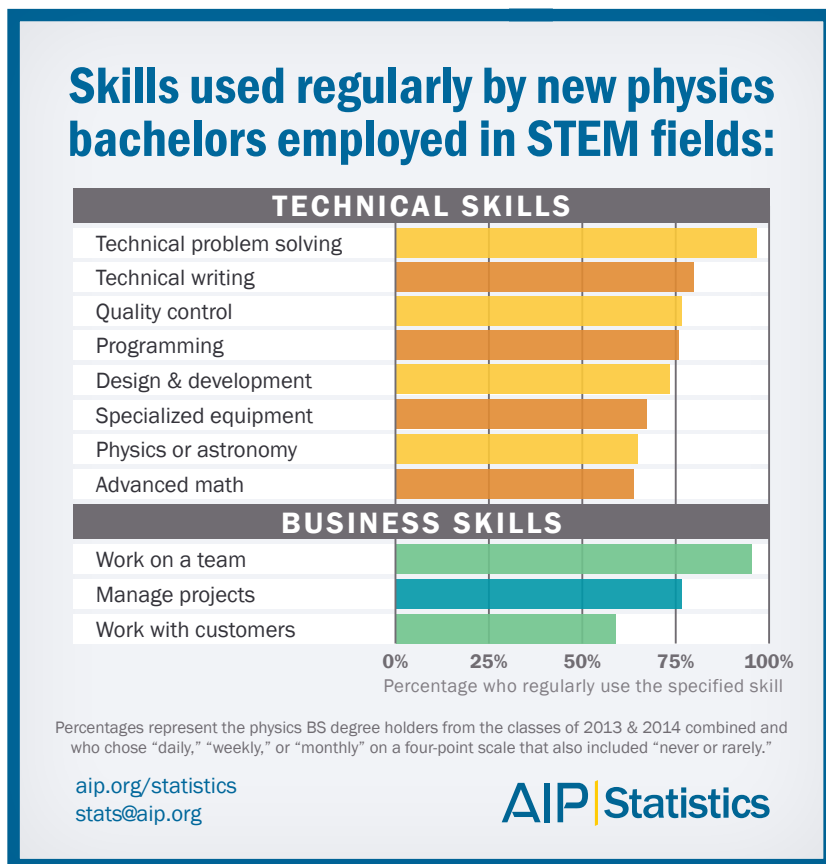
The students participating in the project are Cioli Barazandeh, Maryam Mohagheghi, and Angel Gutarra-leon.

### ABOUT THE AUTHOR

**Cioli Barazandeh received her associate's and bachelor's of science in space studies from American Military University at the ages of 12 and 13, consecutively. She began graduate coursework at the Florida Institute of Technology (FIT) before completion of her bachelor's. She is currently an FIT graduate student focusing on space systems. She is also concurrently a master's student at Purdue University engaged in the study of aeronautical and astronautical engineering funded by a full scholarship through the School of Engineering. She hopes to achieve her MS from Purdue in December 2018 and finish her MS at FIT (by May 2018), while possibly working on the research component of a doctorate. As the President of the Society of Physics Students, Annandale chapter, at Northern Virginia Community College, she currently studies with Professor Walerian Majewski and physics students, focusing on projects revolving around magnetism and particle physics. //**

1. <http://iopscience.iop.org/article/10.1088/1742-6596/770/1/012050>

2. <https://absuploads.aps.org/presentation.cfm?pid=12611>, <https://absuploads.aps.org/presentation.cfm?pid=12795>



# Poetically Speaking

by Bria Andrews, SPS Member, and Paul Gueye, SPS Advisor, Hampton University

In January 2017, our Society of Physics Students chapter held its first poetry contest. The contest was open to everyone on campus and initiated by Bria Andrews, our chapter president and an undergraduate senior physics major. The idea to start a poetry contest stemmed from a project that required her to research a topic unrelated to her major. That led to a paper titled “It’s More Than Just a Rhyme: When Poetry Turns to Hip Hop” and this poetry contest.

As an artist, Andrews frequently dances and writes. This research investigated historical analyses of poetry from the Harlem Renaissance, Black Arts Movement, and the present, with Langston Hughes, Gil Scott-Heron, and Rakim as figures of each era. Focused on musical analysis and meaning, as well as connection to the community, the project ended by relating the evolution of poetry into hip hop to Susan Cain’s book *Quiet: The Power of Introverts in a World That Can’t Stop Talking*.

Andrews enjoyed studying this topic and was asked to present her work dur-

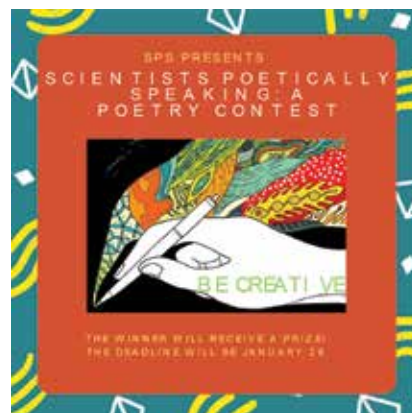
ing a physics colloquium at Hampton. This experience encouraged Andrews to help her colleagues get their creative juices flowing. Students could write about anything and everything.

Hosting this contest helped our chapter bond over nonphysics topics. In addition, it exposed SPS to other majors and organizations on campus that don’t normally interact with the physics department. The winning entry, “Rain,” was submitted by Angelina Gallego. It is a tanka, a Japanese form of poetry similar to haiku.

## “RAIN,” by Angelina Gallego

I cried that last tear  
The cloud consumed the sunlight  
Day turns into night  
I wish that I could be free  
So no one would enclose me

**About “Rain”:** “Sometimes people put you down in your life and tell you about the things you cannot achieve. People told me I couldn’t be a physicist, that I would not make it, and that I didn’t have



the skills or money to even go to college. My poem represents my internal struggle with the way words affect me and how my passion always helped me fight thoughts of self-doubt. One thing that always made me feel free was doing what I love, which is learning physics, and I will continue to never let anything that anyone tells me deter me from the passion I have for physics.” –Angelina Gallego //



**TOP:** The poetry contest flyer. Image courtesy of the Hampton University physics department.

**BOTTOM:** Poetry contest winner Angelina Gallego. Image courtesy of Angelina Gallego.



# SPS Chapter Inspires Love Under the Stars

by SPS Members, University of Nebraska - Lincoln

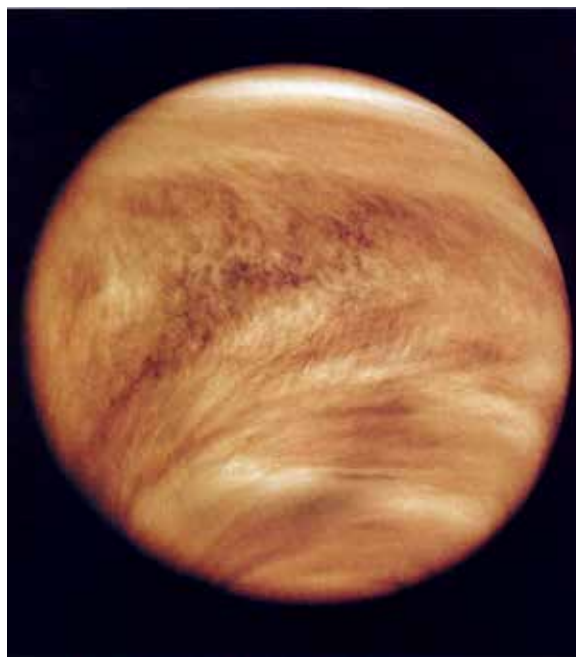
**About 40 miles from the University of Nebraska - Lincoln (UNL) sits Behlen Observatory, housing a 30" Schmidt-Cassegrain telescope. While this telescope is most commonly used for research, the UNL Department of Physics and Astronomy hosts open-house nights that enable the public to find awe in the vastness and beauty of space. Attendees span from children, to high schoolers, to couples who are there for a romantic evening under the stars.**

In February, we structured Behlen Night around the theme of love because it was close to Valentine's Day. Events included a talk by our own UNL astronomer, Michael Sibbersen, titled "Venus, the Planet of Love ... Or Is It?!"

Continuing with the theme, our SPS group did a variety of demonstrations related to the planet of love. This included a pressure demonstration in which visitors attempted to lift a plate off a table. However, no matter how hard they tried, a pressure difference made it impossible. This highlighted the immense atmospheric pressure on the surface of Venus. Our February open house was a fun way to combine science with the holiday.

Not only do attendees at our open houses enjoy looking at the starry sky, they also enjoy learning a little bit more about how the world around them works. Our SPS chapter always engages visitors with a variety of demonstrations on topics that range from angular momentum to spectroscopy to the Meissner effect. We hope to show people how important the sciences are. Generally, about 10-20 volunteers come out and help with these events, which are attended by up to a few hundred people.

One of our most popular demonstrations involves serving liquid-nitrogen-cooled marshmallows. Dipping the marshmallows in liquid nitrogen causes the long chains that make up the polymer structure of marshmallows to constrict, turning the usually pillowlike marshmallows into hard, chewy candies. This is an easy and quick demonstration, as we simply dip marshmallows in liquid nitrogen and give them to visitors on toothpicks. The kids especially love getting a treat while learning how cool science can be.



**TOP:** A view through the dome at Behlen Observatory. Photo by Mike Machian, Shoot To Fill.

**BOTTOM:** Venus is the namesake of the ancient Roman goddess of love and beauty. This ultraviolet image of the cloud-covered planet was taken by the Pioneer Venus Orbiter in 1979. Credit: NASA.

As a chapter, we genuinely enjoy inspiring kids to continue learning about science. In fact, some of our SPS members remember going to these open houses when they were little, and they are now on a path towards a degree in science! //

# INTRO: WHY RESEARCH?

**by Brad R. Conrad, PhD,**

Director, Society of Physics Students & Sigma Pi Sigma

Physics is an experimental science and, by its very nature, is broad in scope and application. Sometimes, that makes it difficult to explain to someone what physics research is, as it means your questions are limited only by your drive and imagination. In a very real sense, the possibilities are endless. The world is our lab, and physics research can occur anywhere: making circuits in the lab late at night, scouring historical texts and documentation, exploring new fields through summer internships, conducting life-changing outreach activities, or working in industry. Spanning the full range from bench science to computational modeling to theoretical musings, research for physicists and astronomers is as broad as our courses: mechanical, computational, thermal, biophysics, quantum, electronics, and the list goes on. This breadth is great news for us because it that means we can be found solving problems in a wide range of situations and getting into all manner of trouble.

Research experiences, whether over the summer at a national lab or done between classes during the semester, can alter your career pathway and, just maybe, our entire understanding of some physical system. No matter where you go, you'll always be a physicist.

This issue of *The SPS Observer* focuses on undergraduate research experiences, and we hope it's just the thing you need to read before you get started on your own research experiences. Keep in mind that research is what you make it, and if it were easy, it would probably already be done! By challenging ourselves and our knowledge, we can begin to understand the unknown.



## LABORATORY SAFETY IS A CRITICAL COMPONENT

of any research program. The laser-safety goggles pictured here on a bench within the Charles R. '62 and Judith G. Munnerlyn Astronomical Laboratory at Texas A&M University are essential in safeguarding the eyes against potential damage from ultraviolet light sources used to calibrate astronomical imaging systems for any number of international projects, from the Dark Energy Survey to the Giant Magellan Telescope. To learn more about Texas A&M's astronomy program, its annual National Science Foundation-funded Research Experiences for Undergraduates (REU) Program on astronomical research and instrumentation, and its distinct competencies in both world-changing areas, visit <http://instrumentation.tamu.edu>.

### FIND ADDITIONAL OPPORTUNITIES

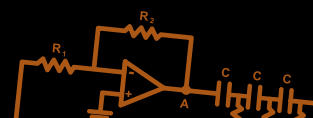
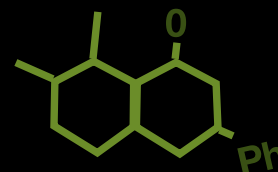
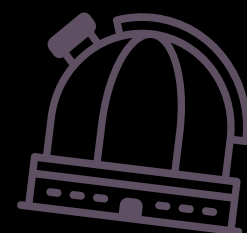
#### Search the NSF REU Sites

Search for National Science Foundation (NSF) REU sites, including those in astronomical sciences, physics, materials research, and more, at: [www.nsf.gov/crssprgm/reu/reu\\_search.jsp](http://www.nsf.gov/crssprgm/reu/reu_search.jsp).

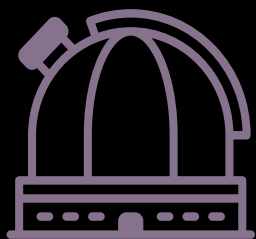
#### Find Research Opportunities and Internships on SPS Jobs

SPS Jobs is the ideal place for undergraduates to find exciting REUs and summer internships, along with full-time Bachelor-level jobs in science and engineering. Prime REU hiring season is September thru February, so REGISTER NOW with SPS Jobs and create job alerts to notify you of relevant new listings as they're posted. SPS Jobs is part of the AIP Career Network, a collection of online job sites for scientists, engineers, and computing professionals managed by the American Institute of Physics.

Visit **SPS Jobs** to search for opportunities and create your profile at <http://jobs.spsnational.org>.







# NAVIGATING YOUR RESEARCH EXPERIENCE AND MAKING THE MOST OF ROUGH WATERS

by **Victoria DiTomasso**, Summer 2016 SPS Intern, City University of New York – Hunter College

FEATURE

If you sit in on a group meeting of the Brown Dwarfs in New York City (BDNYC) research team, you will see a group of students and research scientists discussing their astronomical research on brown dwarfs, colloquially known as “failed stars.” You may notice the group members receiving feedback on their work, as well as on how they present it. You will probably note that BDNYC consists mostly of women.

Led by Drs. Kelle Cruz (CUNY<sup>1</sup> Hunter College/AMNH<sup>2</sup>), Jackie Faherty (AMNH), and Emily Rice (CUNY CSI<sup>3</sup>/AMNH), the members of BDNYC investigate a variety of topics in brown dwarf science, have published over a dozen research papers, presented the group’s work at dozens of conferences, and have traveled to observatories in Arizona, Hawaii, and Chile to use telescopes there. I have been a member of the BDNYC research group since the summer of 2015, and I have found that my own success, and that of my fellow BDNYC-ers, has



**ABOVE:** The Pls of BDNYC. Left to right: Drs. Jackie Faherty, Emily Rice and Kelle Cruz. Photo courtesy of Victoria DiTomasso.

**BOTTOM LEFT:** Victoria DiTomasso. Photo courtesy of the American Institute of Physics.

been largely thanks to the mentorship of our group leaders and the support of the group as a whole.

Drs. Rice and Cruz agree that the quality of your research experience and your relationship with your research advisor are limited by the mentoring skills of the advisor and the environment of the lab. As a student, however, you can be proactive about finding a supportive research advisor and a lab in which you can succeed.

Before pursuing a professor to work with, Dr. Rice recommends, “[T]hink two steps ahead—know what you want to get out of the research experience.” This isn’t just a chance to see what you like in research or an opportunity to practice presenting at conferences. You should also think of your potential research advisor as someone who will be writing your letters of recommendation for grad-

uate school or for a job application.

You will need to do your research (pun intended) into a lab to assess if it could be a good fit for you. Dr. Cruz warns, “In physics, there is a culture of making the most out of one’s accomplishments that one possibly can, and that can be very intimidating to a lot of people. It seems to disproportionately discourage women. In my experience, the more women there are in a group, the less of that there is.”

Dr. Rice has had a different experience. Her PhD thesis advisor was a male, senior faculty member, “but he was supremely understanding of personal and family issues.” It was from him that she learned “the more understanding and supportive you are, the more your students can thrive.”

Although the gender makeup of a lab can be an indicator of how collaborative

or competitive it may be, it is best to talk to students that have experience working in the lab.

Dr. Cruz suggests, "If you've figured out that you like more individual attention from your advisor or that you like to work more independently, the people in the lab can give an accurate description." She says, "It is even okay to send an 'I don't know you' email. Like, 'Dear Julie, I see that you worked in the Smith Lab last year. I'm considering joining that lab. Would you have five to ten minutes to chat on the phone about that experience?'" This is an especially important step for women students, who are at higher risk of facing harassment throughout their career, because "if a lab has a problem, people will let you know about it privately."

Despite even the best research, you might find yourself in a lab or with a research advisor that is not a great fit for you. Dr. Rice had a research experience early on in her career in which the advising and peer community were less than optimal for her. To students in a similar situation, she suggests, "As you're going along, evaluate your relationships and what you're getting out of them. You may need to find someone else to fill the gaps...make the mentorship you need, and that includes peer mentorship as well as faculty mentorship." Dr. Cruz also stressed the importance of building a network of peers. "It takes a village of mentors at all seniorities, [and students should] be deliberate about recognizing the mentorship opportunities."

If you are in a lab and having a negative experience, Dr. Cruz recommends, "taking as many learning opportunities as you can away from it so that you don't reproduce [the experience later]." If you had a bad research experience, it is important to be cognizant of what made it bad. "Was it the science, the advisor, the place, or the research?" Dr. Cruz says.

Be careful of falling into the trap of thinking your experience was negative because you felt that you were not making progress in your research. "There is very little wasted time in research," notes Dr. Rice. "Inefficiency [in re-



**LEFT:** Pictured left to right: Lil' BD (the BDNYC mascot), Haley Fica (Undergrad at Barnard College), Munazza Alam (Undergrad at CUNY Hunter College, currently attending graduate school at Harvard University), and Sara Camnasio (Undergrad at CUNY Hunter College, currently attending graduate school at NYU) at Las Campanas Observatory in Chile.

**BELOW:** Pictured left to right: Haley Fica, Munazza Alam, and Sara Camnasio. Photos courtesy of Victoria DiTomaso.



search] is where the interesting things get done. The inefficiency is necessary because that's what research is. It's not a linear path to an answer."

Research experience is extremely valuable to students, because, as Dr. Cruz says, "Being a good scientist is not about getting good grades in a science class—it's about being good at research." Students have the capacity to set themselves up for a positive ex-

perience and to get the most out of a less-than-ideal situation. Even a wholly unpleasant experience can provide you with insights that will impact your decisions when it comes to your career path. //

1. City University of New York.
2. American Museum of Natural History.
3. College of Staten Island.





# SEVEN SUGGESTIONS ON HOW TO MAKE AN AWESOME\* POSTER

by **Brad R. Conrad, PhD**, Directory of Society of Physics Students and Sigma Pi Sigma

*\*People's preferences vary for posters, so make sure you get expert opinions before you print.*

## 1. TAILOR YOUR PRESENTATION TO YOUR AUDIENCE!

<b>Experts within the field</b>	<ul style="list-style-type: none"> <li>• Shorter background</li> <li>• Identify field significance</li> <li>• Key results</li> <li>• Highlight new techniques</li> </ul>
<b>Colleagues</b>	<ul style="list-style-type: none"> <li>• Stress background</li> <li>• Clear presentation</li> <li>• Detailed processes &amp; data analysis</li> </ul>
<b>General public</b>	<ul style="list-style-type: none"> <li>• Strong background</li> <li>• Clear motivation</li> <li>• Relate to their background</li> <li>• Answer a clear question</li> </ul>

## 2. SELECT A GOAL FOR YOUR POSTER

- Your poster is a visual guide to reference while you present.
- The poster should not distract the audience but instead be a tool to transfer information.
- If the poster is meant to hang in a hallway or lab for a long time, it is OK to include more detail.

## 3. PURPOSE

- Posters are well-suited for presenting a logical argument to a small number of people.
- Conversations often end up being bidirectional and people will be talking to you, not reading the poster very much.
- Posters are fantastic for in-depth, technical discussions.
- Develop a clear, singular message.
- Identify what you want your audience to take away.



## A Generic Poster Template

Brad R. Conrad<sup>a</sup>

<sup>a</sup>Society of Physics Students, American Institute of Physics  
<sup>b</sup>Department of Physics and Astronomy, University of Colorado

### Motivation

A strong motivation is key to keeping your audience's attention. A sentence or two is often good enough.

### Introduction

This section should include background information necessary to understanding any theory or results seen later on.

### Poster size:

- Common size: 3' tall by 4' wide

### Fonts:

- Pick one and stick to it.
- Be consistent with formatting titles, bullet points, and tone.
- Pick an easy to read font.
- Sentences get a period at the end.

### Font Size Recommendations

Poster title	90 pt
Authors	60 pt
Affiliations	56 pt
Section Titles	60 pt
Main text	32-36 pt
References	> 28 pt
Highlights	40 pt or bold

*Note: It's your poster, so you can make them whatever you want. These are just suggestions.*

*Avoid too many colors.*

### Data

### General Advice

1. Identify your **audience**.
2. What is your poster's **goal**?
3. A poster is good for two-way communication.
4. Keep **text short** and figures long.
5. Have a clear message.

### Common Poster sections:

- A short title - clear main topic
- List authors with affiliations
- Optional: Contact information
- Motivation – Most important
- Introduction
- Theory, Methods, and Data
- Analysis – Separate from Data
- Results
- Conclusion (not identical to results)
- References
- Acknowledgements/Logos/funding

### Equations

Insert equations. Avoid asterisks \* for multiplication and carets ^ for powers. Use the equation editor. Example:

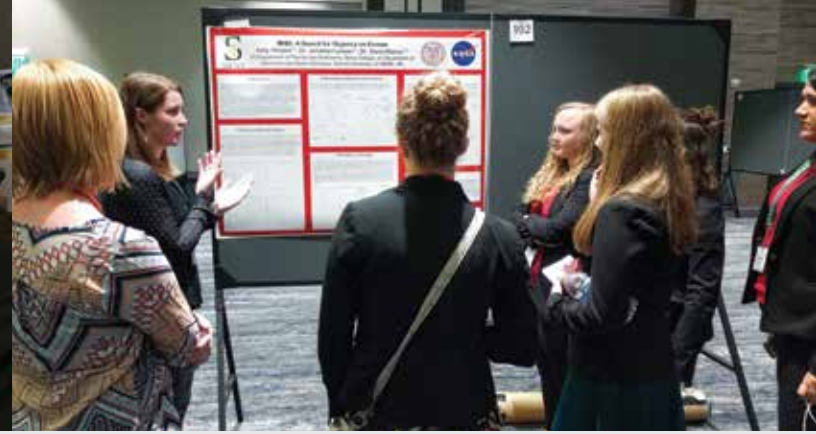
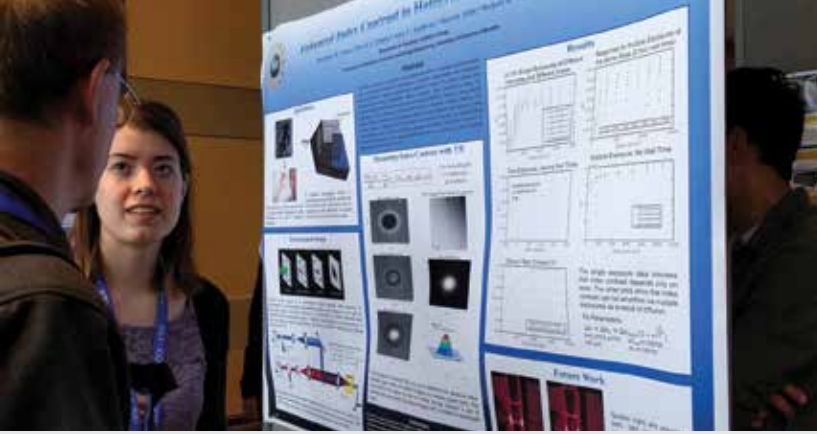
$$P = \sigma A e (T^4 - T_{oc}^4)$$

Define variables:

P = Power A = area

T = Temperature ... etc.






SPS MEMBERS PRESENT their posters at AIP Member Society Meetings. Photos courtesy of AIP.

# Poster Template with Tips

and Annie Atom<sup>b</sup>  
 Institute of Physics, College Park, MD 20740  
 University of Cool Physics, Neverland, WA 12345



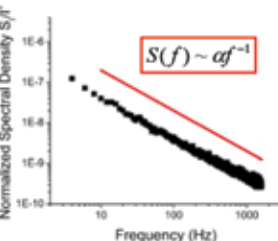
## Tables and Data Presentation

- Tables are often not the best way of showing results.
- Graphs are easier to read.

Measurement	Typical Value	Typical Uncertainty	Fractional Uncertainty
Voltage – Measured	1.00 V	0.02 V	2 %
Voltage – Reference	1.1 V	0.1 V	9 %
Frequency Shift 1	1140 Hz	41 Hz	4 %
Frequency Shift 2	1081 Hz	32 Hz	3 %

**Table 1.** Label tables and figures so that readers can understand them even if don't mention them.

## Analysis



**Figure 1.** Graphs should be large, easy to read, and not cluttered. Beneath, text which explains the graph can be helpful but is not always necessary. *If there is a data fit or guide, put that equation on the graph.*

## Results

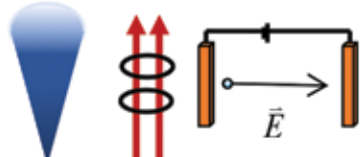
- Summarize the results of your data
- Relate to motivation and introduction
- Clearly state the significance to the broader field and the general public
- Report key values and relationships

Pay particular attention to your audience.

Only keep results that support the main poster message

Provide a clear, logical flow of information.

Keep it simple and straightforward



**Figure 2:** If you want to add Figure captions, they can be small. Keep them short and simple. Label!

## Conclusions

Takes a long time to make a good poster

- Seek revision
- Receive feedback from collaborators
- Be clear, concise, and directed

### References

Cite your sources! Any images you use should be cited if you didn't draw them. Here is an example:

1. B.R. Conrad, W.G. Cullen, W. Yan, and E.D. Williams, Percolative effects on noise in pentacene transistors, *Appl. Phys. Lett.* 91, 242110 (2008)

### Acknowledge funding

SPS travel award 2017 & support from Student Research Office.

#### 4. FIGURES & PHRASES

- Figures should be large, clear, and well labeled.
- People will not read paragraphs of text.
- Use phrases and bullet points.
- Keep text to the essentials.
- Include only just enough information for someone to follow along if you are not there.

#### 5. PROFESSIONALISM

- Don't ignore anyone.
- Let people ask you questions.
- Don't speak over them.
- Dress to impress.
- Never eat while presenting.
- Don't have note cards.
- Thank people for speaking with you.

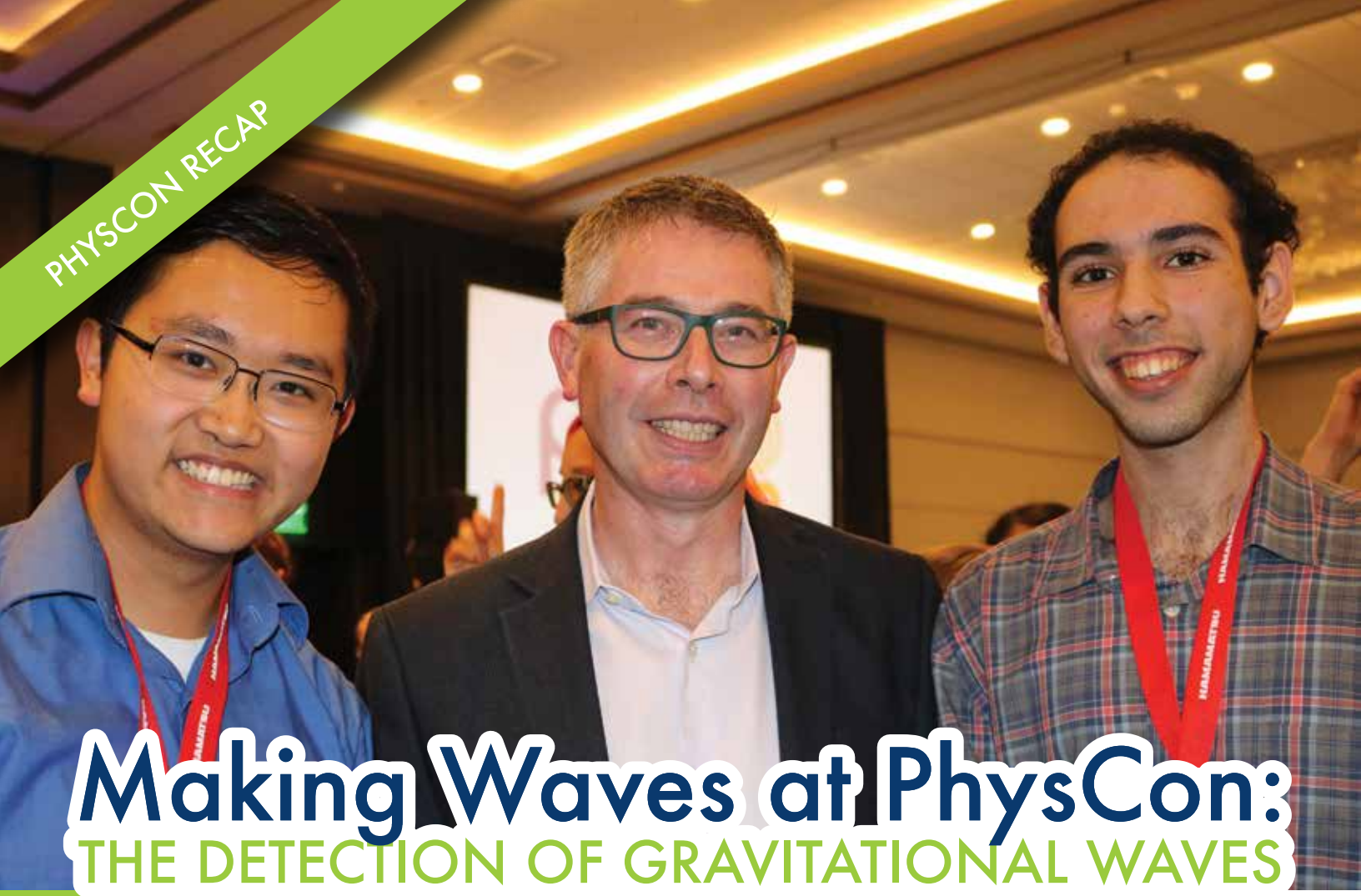
#### 6. FOCAL POINTS

- Motivation – Provide a clear motivation for your research.
- Make sure you have all the necessary figures You never want to think in the middle of your poster session, "Oh, I wish I had a figure which explained that."
- You need to practice your poster explanation several times. Ask both colleagues & non-experts.

#### 7. DESIGN

- Posters are read left to right, top to bottom.
- Three column designs are common (see figure).
- Less is more. Stick to the message.
- Results and conclusion go on the right side of a poster.
- Put references and acknowledgments at the bottom.
- Either make all your own figures (preferred), or cite them appropriately. Avoid plagiarism.
- Favor graphs over tables.

For more information on preparing an effective presentation, see "Preparing an Effective Presentation" on p. 28



# Making Waves at PhysCon: THE DETECTION OF GRAVITATIONAL WAVES

by Chunyang Ding, Suryabrata Dutta, and Mehmet Tuna Uysal, SPS Reporters, Yale University

The detection of gravitational waves from the collision of two 30-solar-mass black holes made international headlines when it was announced last year, confirming a fundamental prediction of Einstein's theory of gravitation. With a detection accuracy of one part in one thousand thousand thousand million, the Laser Interferometer Gravitational-Wave Observatory (LIGO) collaboration saw the "chirp" of two black holes—roughly 1.3 billion light years away from Earth—merging together. Dr. Patrick Brady, director of

the Center for Gravitation, Cosmology and Astrophysics and a professor at the University of Wisconsin, Milwaukee, gave the closing plenary at PhysCon on his work with LIGO as a former director.

Before the talk and throughout the weekend, several plenary speakers, including Dr. James Gates, Dr. Neil Turok, and Dr. Jocelyn Bell Burnell, alluded to how gravitational waves would transform both experimental and theoretical physics. "I've followed gravitational wave research for 45 years. I knew it would be difficult to detect. I wasn't sure it would happen in my lifetime; I'm delighted it has," said Dr. Burnell, the honorary chair of PhysCon. Undergraduates at the conference shared in this excitement and were eager to hear about the discovery.

The detection of gravitational waves has already been heralded as one of the most profound discoveries of the decade. Gravitational waves were first predicted by Einstein's theory of gravity as energy that dissipates through accelerating masses, but even Einstein thought they would remain forever undetected. Detecting the gravitational waves from a black hole merger event requires a precision equivalent to measuring the distance from Earth to the star Alpha Centauri down to the width



2016 Quadrennial Physics Congress



**LEFT:** From left to right: Chunyang Ding, Dr. Patrick Brady, and Mehmet Tuna Uysal.

**ABOVE:** Dr. Patrick Brady talks at the closing plenary session at PhysCon 2016. Photos courtesy Chunyang Ding.

of a single human hair. To perform this ultraprecise detection, physicists Rainer Weiss of MIT, Kip Thorne of Caltech, and Ronald Drever of Caltech designed a laser interferometer, something that can measure tiny disturbances using laser interference patterns. While simple in principle, the actual instruments—one in Hanford, Washington, the other in Livingston, Louisiana—have arms stretching out 4 kilometers.

In his talk, Dr. Brady provided an in-depth exploration of the science that led up to the detection of the gravitational wave on September 14, 2015, paralleling the timeline of human events with the approximate location of the gravitational wave. He pointed out that as humanity first began to use stone tools 2.5 million years ago, the gravitational wave was passing through the Andromeda galaxy; as Newton first described gravity 329 years ago, the wave had passed by the Pleiades; as

the advanced LIGO project was coming online, the gravitational wave had already entered our solar system.

Dr. Brady spoke at length about the many physicists whose research was instrumental in this detection, showing that physics is a huge collaborative effort. The LIGO collaboration alone has a thousand scientists across 80 institutions and 15 countries. Even though Dr. Brady is one of the leaders of this discovery, he remains humble. "I feel really lucky that I got the chance to be part of the team," said Dr. Brady.

Throughout the talk, Dr. Brady frequently returned to the human aspect of the research, encouraging the crowd of young scientists to pursue their dreams, whatever they are. He peppered the history of the great physicists of the 20th century with remarks about his own childhood, and frequently nodded to other PhysCon speakers, especially the talks by Dr. Jocelyn Bell

Burnell and Dr. Persis Drell and their remarks on diversity. In the closing minutes of the plenary, Dr. Brady charged all students to seek out diverse collaborations. "This isn't about us as individuals. This is about us as a group, this is about us as a society," he said, receiving thunderous applause from the audience.

The future is bright for gravitational-wave detection opening a new spectrum for fundamental physics and astronomy observations. The detection of large black hole merger events is already shaking up our understanding of black holes. As new interferometers come online in the future, they will provide more and more discovery opportunities for physicists around the world.

Throughout the 2016 PhysCon, students were challenged and encouraged by the speakers to be creative thinkers, passionate about solving physics mysteries. "My opinion is that



# Communicating Science: Thoughts from the Editor of the Yale Scientific Magazine

by Chunyang Ding, SPS Member, Yale University



[HTTP://WWW.YALESCIENTIFIC.ORG/](http://www.yalescientific.org/)

**How did you first get interested in science? Perhaps your parents took you to a planetarium and you saw the dance of the stars, or maybe you saw a PBS special on giant particle accelerators and knew you had to get your hands on one. All this is good scientific communication, where the abstract math and theory that rules our world is carefully explained to a more general audience. It is the responsibility of every scientist to effectively communicate their research to a general audience—you shouldn't need a PhD to appreciate the sublime beauty of nature! After all, what good is a discovery if no one understands it?**

The *Yale Scientific Magazine* has a core mission to pursue clear and concise scientific journalism. Founded in 1894, the nation's oldest college science publication is now completely run by undergraduate students and publishes four issues per year. Every issue features cutting edge research taken straight out of journal articles, but written in a way that is accessible to everyone. We have a drive to reach more people with the fascinating story of science, following the research by reading the original report, interviewing researchers, and discussing with section editors. Our magazine reaches thousands of people in print copy and hundreds of thousands online every year.

There is no better place for aspiring physicists to become involved in scientific communication than in college. As a student, you have access to the scientists active in research and the time to understand their work. It may be easy to get started with your own blog, but don't overlook traditional resources. Reach out to the chair's office for your school's physics department and let them know that you want to cover research from your university. Speak to your local newspaper, city or university, and ask for an article assignment. Look for research journals on campus, or even inter-university projects that help multiply the number of people who end up reading your work. Bringing new knowledge to the world is a great experience that all students should take part in during their undergraduate years.

At the *Yale Scientific*, our writers find it remarkably fun to work on a piece, even on topics that are completely foreign to them. The process of scientific journalism is not always easy, but it is deeply rewarding and gives back to your local community. We encourage everyone to explore it, and to perhaps instill your wonder of the physical world to the next generation.

**Chunyang Ding is Editor-in-Chief of the *Yale Scientific Magazine* and is a sophomore physics major. You can contact him with questions at [ysm@yale.edu](mailto:ysm@yale.edu), or online at [www.yalescientific.org](http://www.yalescientific.org). //**

there are lots and lots of interesting things to do and to learn in this world," said Dr. Brady. "Don't latch onto one too early. Realize that you have options, and when you are doing one, focus on it, and you'll do well."

For the full version of this article, visit: [//">http://www.sigmapisigma.org/congress/2016/articles/making-waves-at-physcon //](http://www.sigmapisigma.org/congress/2016/articles/making-waves-at-physcon)

## UPCOMING AIP MEMBER SOCIETY MEETINGS

**Are you interested in attending a scientific meeting and writing about your experiences for an upcoming issue of the *Observer*?**

**Check out the upcoming meetings below and consider applying to be an SPS Reporter. Reporters receive up to \$200 to support their travel.**

**Apply online at: [www.spsnational.org/awards/reporter](http://www.spsnational.org/awards/reporter)**

### **230th American Astronomical Society (AAS) Meeting**

June 4 – 8, 2017  
Austin, TX

### **173rd Acoustical Society of America (ASA) Meeting**

June 25 – 29, 2017  
Boston, MA

### **American Association of Physics Teacher (AAPT) Summer 2017 Meeting**

July 22 – 26, 2017  
Cincinnati, OH

### **American Association of Physicists in Medicine (AAPM) Annual Meeting**

July 30 – Aug 3, 2017  
Denver, CO

### **Society of Rheology (SOR) Annual Meeting**

October 8-12, 2017  
Denver, CO

# GET READY FOR THE GREAT AMERICAN ECLIPSE

by Richard Tresch Fienberg,

Press Officer, American Astronomical Society, Sigma Pi Sigma Rice University Chapter, Class of 1978

**Monday, August 21, 2017. Mark your calendar. For the first time in 38 years, a total eclipse of the Sun is coming to the continental United States.**

Unless you're a member of the small but growing cadre of "eclipse chasers," you've probably never seen a total solar eclipse before, as they tend to occur in far-flung places requiring costly travel. Not this time. On August 21, the Moon's 70-mile-wide shadow will cross the country from Oregon to South Carolina, turning day to night for an estimated 12 million people who live within the narrow path of totality. You should make every effort to get into the path, too.

Here's why: During a total solar eclipse, the Moon blocks the Sun's bright face—the photosphere—briefly revealing our star's outer atmosphere: the shimmering corona, or "crown." Made of rarefied gas heated to millions of degrees and sculpted into streamers and loops by the Sun's powerful magnetic field, the diaphanous corona shines with a light seen nowhere else. It is hauntingly beautiful and, without doubt, one of the most awesome sights in all of nature.

The corona is always there, but we usually can't see it because the photosphere is about a million times brighter. When the Moon covers the Sun, the corona is the main attraction. And that's not all. At the beginning and end of totality, the thin middle layer of the Sun's atmosphere—the chromosphere—blazes in an arc of ruby red. The sky darkens to a deep twilight blue, with yel-

low, orange, and pink sunrise/sunset colors on the horizon in all directions. Bright stars and planets shine forth, and the air temperature drops noticeably. Birds and farm animals, thinking dusk has settled, return to their nests and barns, and bats come out to feed.

Outside the path of totality, all of North America will get a partial solar eclipse. But even a 99 percent partial eclipse pales in comparison to a total one. It's like buying a ticket at the box office, standing outside the theater, and saying you've seen the show.

Depending on your location, the corona

will be visible for up to 2 minutes, 42 seconds. During those precious moments, it is perfectly safe to look directly at the Sun, even through binoculars or a telescope. But whenever any part of the photosphere is uncovered, it is absolutely essential to view the Sun through a safe solar filter—that is, one that meets the ISO 12312-2 international standard. Such filters are widely available at affordable prices. Looking at the uneclipsed or partially eclipsed Sun through dark sunglasses or any other unapproved filter is a recipe for serious and potentially permanent eye injury. //

**Want to know more?** With funding from the National Science Foundation, the American Astronomical Society has created a special eclipse website at <https://eclipse.aas.org> with basic information and links to more detailed resources. Visit today!



**TOP:** Solar eclipse transition from Cairns, Australia. Image credit: iStock.com.

**ABOVE:** The path of the total solar eclipse of August 21, 2017. Image courtesy of Michael Zeiler.

# Recipe for Success: Tips for a Stellar Summer Internship

by Kerry Kidwell-Slak, Assistant Director of SPS and Sigma Pi Sigma

**Day one of your summer REU or internship. It feels like you've already done the hard stuff: prepared a stellar one-page resume that highlights your most relevant skills, gotten recommendations from your professors, maybe written a cover letter or personal statement about why this internship is exactly what you want to do, and perhaps even navigated through a challenging technical interview. Now it's just a matter of showing up, right? Not quite.**

Many organizations hiring interns see a summer position as a 10-week-long job interview. While they hope and expect that you will make some concrete contributions, they are also continuing to assess your suitability for the field and whether they would want to bring you on as a professional colleague someday. According to the National Association of Colleges and Employers, employers made job offers to 72.7% of their interns.<sup>1</sup> Having gone through an application process does mean that your organization believes you have a lot to offer and that you are capable of doing the work, but there is still a great deal you can and should do to make the most of your experience. Here we'll lay out some of our top tips for impressing your supervisors and hopefully leveraging your summer experience into one more step on your career path.

## 1) LEARN ALL YOU CAN.

You are in charge of your learning. Taking on an internship means engaging in an experience in a professional setting where you are going to be challenged to learn new things. But, unlike school, there's typically no syllabus to guide you and no final exam to assess what you learned. Take the reins to make sure you learn all you can. One of the best ways to do this is to meet with a supervisor early in your internship to talk about what you both expect from the experience and lay out concrete learning objectives and how you will work to achieve them. For example:

- a. Learning Objective: Author a white paper on a technical topic suitable for an audience of policymakers.
- b. Action Plan: Read a variety of sample papers and develop drafts with input from my principal investigator.

Take time to formally revisit these objectives throughout the summer to make sure you are making progress and get feedback on your work habits.

## 2) ENGAGE IN SOME ANTHROPOLOGICAL RESEARCH.

Integrating yourself into a new organization requires doing some research. You may have done this during the application process, using websites or by talking to other current or past interns, but for many interns this research begins in earnest on your first day. Observe those around you, paying close attention to the people you are going to be working closely with. What do they wear? How do they

interact? Do people practice an open door policy and pop in to one another's offices, or is e-mail, phone, or instant messenger preferred? How do meetings run? Taking the time to understand and apply these "unwritten" rules of your organization shows savvy and will get your summer off on the right foot.

## 3) RESPECT THE CLOCK AND CALENDAR.

Being punctual and meeting deadlines isn't just being polite—it's showing respect for your colleagues and reflects on how seriously you are taking your responsibilities and the experience. Plan to be at least five minutes early for meetings and complete tasks before the day they are due. If you know you are going to be late, don't wait until the deadline or meeting time to tell your supervisor. Give them early notice of delays and work with them to brainstorm ways to possibly bring in additional resources to get the work done on time.

## 4) BUILD A STRONG RELATIONSHIP WITH YOUR SUPERVISOR.

The supervisor-intern relationship is one of the most critical. Your supervisor will likely be the one who decides what





kind of projects you will work on, how much autonomy you will have in your work, and will play a role in getting you connected throughout the organization. Hopefully, they will also end up being a reference and mentor for you. Laying the groundwork to have this person in your camp is key! Spend time with your supervisor to understand what is really important to them. Early on in your internship it may be helpful to have short check-in meetings with them every few days to make sure you are on the right path, get feedback on your assignments, and ask questions. As you gain more confidence, these meetings can become more infrequent.

But what if your supervisor seems too busy for you? The odds are they are busy, but you are an important part of their work and by hiring you they assumed the responsibility of helping you learn and grow. This is an occasion when it is critical that you step up and take a leadership role in the relationship. See if you can schedule just 30 minutes once a week on their calendar, or, if they are better over e-mail than in person, get in the habit of sending them a message every week with the tasks you are working on and asking for feedback. Also, make sure that when you do meet with them, you are making the most of the limited time you have. This means writing down questions in advance and making sure that you have done all you can independently to find answers in advance. Navigating this kind of relationship may be a challenge, but learning how to make the most of it may be one of the most important things you do as an intern.

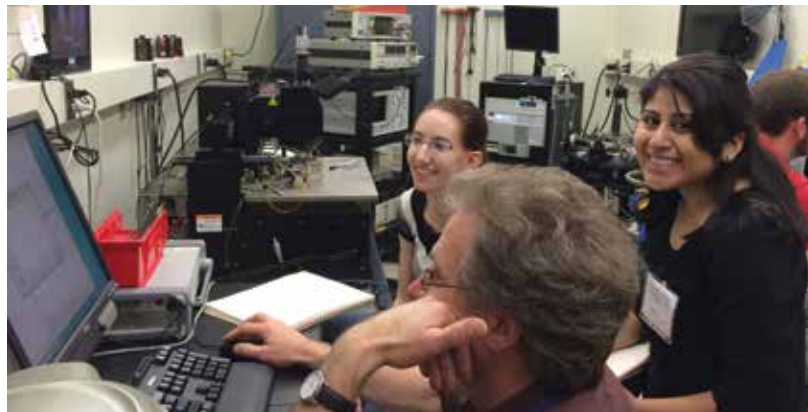
### 5) BE A COMMUNICATIONS EXPERT.

Every workplace is unique when it comes to how people like to communicate. Whether via in-person meetings, over the phone, e-mail, memos, or newer technologies like Slack or Basecamp, you'll need to understand what the expectations are for each medium and navigate them appropriately. Be sure that you always give context for your questions and updates and keep your professional exchanges concise. Take the time to read over anything you write before hitting that "Send" button. If it's a difficult message, like admitting a mistake or asking for an extension on a deadline, consider whether an in-person meeting might be better received than an e-mail. When you receive an e-mail that needs a response, be timely with your followup.

Body language is also important and you should be mindful of your posture, stance, and expression at all times. This means not slouching or putting your feet up at your desk and making eye contact and smiling when you are walking the halls. You never know who is watching and if inadvertent sloppy communication might give someone the wrong impression about you.

### 6) OPEN YOURSELF UP TO SOMETHING NEW.

During your internship, there may be times when you are asked to take on a task you have never done before or occasions when you see a project you don't know much about but are interested in working on. Or perhaps you find yourself with some down time and see a previously unidentified task that your colleagues haven't had time to tackle that would benefit from your skills. Take advantage of these opportunities to show initiative and



**TOP LEFT:** SPS Summer Program Interns pose in front of the AIP office after their final internship presentation.

**BOTTOM LEFT:** SPS Summer Program Interns take flight during an event at the Aviation Museum in College Park, MD.

**TOP RIGHT:** SPS Summer Program Interns pose after a visit to the Minority Office of Committee on Science, Space, and Technology on Capitol Hill.

**BOTTOM RIGHT:** SPS Summer Program Interns are deep in research with mentor, John Suehle at the National Institute of Standards and Technology in Gaithersburg, MD. Photos courtesy of AIP.

jump in feet first. Use your colleagues and the internet to do research and ask questions of your supervisor. Undertaking new challenges is how we all grow and learn.

Every workplace is unique, and this is just a short list of some of the ways you can make sure your summer experience is a success. Keep in mind that you are representing yourself and your school through this experience and take pride in what you do. You may be "just an intern" today, but, by playing your cards right, you may be the one supervising the interns soon. //

1. National Association of Colleges and Employers, "2016 Internship and Co-op Survey: Executive Summary," May 2016, <http://www.naceweb.org/uploadedfiles/content/static-assets/downloads/executive-summary/2016-internship-co-op-survey-executive-summary.pdf>

# Preparing an Effective Presentation

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

**Crafting an effective presentation has significant implications on how we best communicate science and can help propel a career to new heights. It is important to understand the keys to effectively presenting and communicating your work.**

Some of the keys include: identifying your goal in giving the presentation, recognizing your target audience, transmitting a clear and consistent message, developing a clean logical argument, and seeking external feedback on your presentation. As an example, if you are going to a physics conference, you will present information in a much different way than if you were at a job interview or even an engineering meeting. Recognizing the small differences in mindset, audience, and background knowledge can make all the difference between an effective and ineffective presentation. The information below can assist you in crafting your presentation.



## BEFORE YOU START

1. Remember that you've spent weeks, months, or even years learning about your topic, but you need to explain it to someone in only a few minutes. To do this you must motivate the audience to pay attention. Keep in mind that you are already vested in the project and they are a blank slate. Relate the work to your audience, and explain in very clear terms why they should pay attention.
2. The audience must understand your message and if you lose them along the way, most physicists will not believe your work, nor will they be interested in the results. Rather than focusing on the punchline, remember, like a good joke, the setup is often the most important part.
3. Give the audience a very short and clear takeaway. They won't remember most of what you tell them, but you do want them to remember why your presentation is important and any key results you might have. To do this you must repeat yourself in several different ways, visually and verbally. Your presentation should consistently reinforce your takeaway(s).

People can only absorb information so fast. Thus, it is best to have a clear message in each slide or section. Just as with writing, you want to link the parts of a presentation together so that a clear

logical path exists and is easy for your audience to follow. I recommend starting any discussion by saying why what you are about to explain is important and providing a sense of context. Explain any background information, setup, and theory that is needed to understand the work. Clearly delineate between data, analysis and results, as it's not always obvious to people new to an experiment. Make sure conclusions are clear, punchy, and to the point.



## SET A PRESENTATION GOAL

It's perfectly fine for a presentation to have several goals, but you should make sure you identify the key result of your presentation and can voice that key result in a few sentences: aim for about 20 seconds. You want people to remember your work long after they speak with you. Common goals include:

- Sharing a key scientific result
- Highlighting a new publication
- Updating the community on the progress of your research
- Seeking feedback from colleagues
- Distributing the best practices or techniques
- Educating people about new physics
- Marketing yourself and your skills
- Identifying new collaborators

## AUDIENCE TYPES

Before you make a presentation, know who you will be talking to. Will they be familiar with your techniques and terms? How much background might they need to understand your results? Common audiences include:

- General public
- K-12 students
- High school and college students
- Colleagues within the field
- Experts within the field
- Colleagues and experts in neighboring fields
- Funding agencies or outside evaluators

## CLEAR MESSAGING

Once you have established your presentation's goal and you know who your audience is, identify a clear message you want them to

remember. You probably would want colleagues, experts in your field, and scientists/engineers from different fields to take away different things from your presentation. What do you want them to remember?

- Details of a technique
- A key result or realization
- The broader implication of your work to the field
- A new research area
- An interest in collaboration

### LOGICAL ARGUMENT

The key to a good presentation is a linear thought progression for the audience.

1. The chronological timeline of an experiment is usually not the best way to present your findings. Explain your work with the **shortest logical path**.
2. Experiments are messy and often convoluted. Often, you'll do things out of order or go down experimental dead ends which are not helpful to your audience. Since you were figuring things out, you probably did many things that didn't directly contribute to your scientific argument. Be mindful to **only present pertinent information**.
3. You don't need to show the audience every experiment, data set, or experimental curiosity. **Stick to the message**.
4. Be clear, concise, and contain your argument to **one logical flow**. Asides and detours are best left out of a verbal presentation.

Whereas in a book or article readers can skip sections, your audience cannot pick and choose what to pay attention to. They have to assume that everything you are conveying is equally important and vital to the overall message.

### REVISION

Revision is vital for a good presentation. The only way to refine a presentation is to craft one and present it to a critical and responsive audience. You need feedback from a presentation to improve it, because most of us are not very good judges of ourselves. Here are elements you can modify:

- Time spent on each section or slide
- Amount of detail given
- Background information and depth of discussion
- Derivations
- References
- Slide or section information density
- Graphical data representation
- How takeaway messages are highlighted

When you seek feedback, present to people inside and outside your field. They will often identify very different aspects of your presentation for consideration. Also, try to avoid presenting to the same people multiple times. The best feedback is going to be from someone who has not seen your presentation before.

## FOUR COMMON MISTAKES WHEN PRESENTING:

1. For a talk, limit your total slides to less than one slide per minute (e.g. no more than 10 slides for a 10-minute talk). For a poster, have clear sections and titles. You want to give the audience time to think about your statements and not overload them with information.
2. Lengthy derivations and lots of equations are not as helpful as you might think. It is often better to focus on the implications of physical relationships (equations) and leave derivations for detailed papers.
3. Graphs, figures, and tables should focus on and deliver a singular message.
4. Avoid paragraphs of text and stick to phrases or bullet points. People don't tend to read lots of text.

### PARTING ADVICE

The way you present yourself during a presentation is just as important as the actual presentation. Dress to impress. In short, you want to be as well-dressed, if not better, than most of your audience. Business casual is often a safe recommendation for most conferences, while business formal is more appropriate for job interviews. Also, most people have nervous tendencies when they present. The best way to identify your distracting habits is to have someone videotape you presenting, then watch yourself to identify any aspects you don't like. This may feel awkward at first, but it's a very useful tool.

### DON'T FORGET:

- Speak slowly.
- Maintain audience eye contact.
- Know your inflection and facial expressions matter.
- Display your enthusiasm.

Good luck! With these tips your next presentation should be a piece of cake. //



**FAR LEFT:** Frank McKay, AZC Zone 17 and SPS Member, University of Washington, presenting at the APS March Meeting.

**LEFT:** Tabitha Colter, 2016 AIP Mather Policy Intern presenting at the APS April Meeting.

**ABOVE:** Patrick Gemperline, SPS Member, Xavier University (OH) presenting at the APS March Meeting. Photos courtesy of AIP.





# Chasing Rainbows, Part 2

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

**FIGURE 1.** A perfect rainbow. Dorset, UK. Photo © Kris Dutton. <http://www.southernscenicphotography.co.uk/>.

**In the last issue of *The SPS Observer* we tried to answer the question: How far away is a rainbow?**

We concluded that a rainbow is a real image, despite being made up of just reflected light. And we argued that an image of a rainbow—much like your reflected image in a mirror—must be farther away from us than the reflective surface that created it.

But, you may say, "I can form a rainbow with a water sprinkler. The water drops are only a few feet away, and I can see the rainbow between myself and a bush. Surely the rainbow must be nearer than the bush."

Think again of the image formed by a mirror. It appears farther away than the mirror. If we triangulate the water sprinkler rainbow, we find it is much farther away than that bush. This, like many optical illusions, produces cognitive dissonance, for several clues we use for determining distances seem to be giving contradictory information.

Is the cloud of water drops acting like a mirror? Not exactly. The drops capture light from the sun and reflect it internally, and the light emerges going in the opposite di-



**FIGURE 2.** A rainbow from a water sprinkler. Photo by Stephanie Gimenes.

rection but deviated  $42^\circ$  (for red light). This is the reason the rainbow arc has a radius of  $42^\circ$ , centered on the antisolar point, a point determined by a straight line from the sun through your eye.

In fact, the light from any small portion of the rainbow is coming from drops over a wide range of distances, all the way through the cloud, perhaps several miles, not from a simple plane mirror surface.

Now you might suppose that the

size and shape of the individual water drops, each acting as a tiny lens, might determine the apparent distance to the rainbow image. Surprisingly, they do not. The sun is so far away that its light reaching the earth diverges very little. Rays from any point on the sun are nearly parallel when they reach the earth. So all drops receive rays from nearly the same direction, and redirect them back to our eyes, still all nearly parallel. A small caveat: the sun is not a

point source of light. It subtends an angle of about  $0.5^\circ$  as seen from earth, but this doesn't compromise our argument. It only adds a slight blurring to the rainbow image.

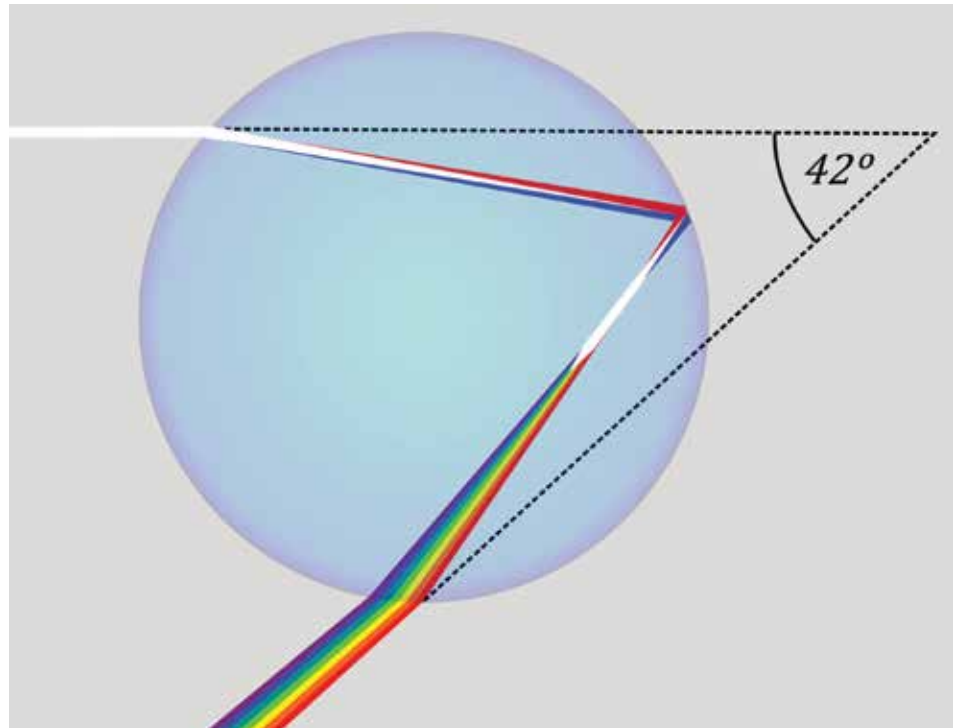
The bottom line is that the rainbow is as far away as an image of the sun would be if reflected by a huge plane mirror at the distance of the cloud of water drops. So "as far away as the sun" is the best answer. But other answers are close enough.

If you accept the rangefinder definition of distance, this result would be confirmed by direct experiment, by sighting the rainbow simultaneously from two widely separated vantage points.

Now that you understand how the rainbow is formed, you know the answer to the question "Why is the center of any rainbow formed by sunlight always below the horizon?" It is simply because the sun is visible only when it is above the horizon. The rainbow's arc is always centered on the antisolar point—on the shadow of your head. You now also know why no one has ever found that pot of gold. There wouldn't be enough gold in it to pay for the trip. And the rainbow would disappear as you passed through the cloud of water drops forming it.

Some nit-picky readers may note that the two lines from the sun through your two eyes diverge slightly, since the sun is not infinitely far away. This would put the rainbow's image just a smidgen beyond infinity. Now we get down to the psychology of vision. Binocular vision can tolerate a slight divergence of the two eyes (at least for most people). The divergence here isn't large. How large?

The sun is  $5.89 \times 10^{12}$  inches away. Human eyes are spaced about 2.5 inches apart. The divergence angle is therefore  $2.43 \times 10^{-11}$  degrees, approximately. You'd never notice such a small divergence. So infinity is close enough for practical purposes. Even with a large baseline rangefinder, of perhaps a mile, the rainbow image is still stuck pretty near infinity—infinity being defined here as greater than any measurable distance. One could also make a case for the fact that the horizon is usually so far away as to be indistinguishable from infinity seen with the naked eyes. But whenever you use the word "infinity" as if it were a number, you are on a slippery mathematical slope. //



**FIGURE 3.** White light separates into different colours on entering the raindrop due to dispersion, causing red light to be refracted less than blue light. From Wikipedia.

### CORRECTION

**In the last issue, *Chasing Rainbows, Part 1*, should have included web links with pertinent topical information. Those are now featured, below:**

- o Rainbow formation. <http://www.physicsclassroom.com/class/refrn/Lesson-4/Rainbow-Formation>. The Physics Classroom.
- o Rainbow stereoscopy. <http://www.science-animations.com/rainbow-stereoscopy.html>. Science Animations.
- o The mathematical physics of rainbows and glories. [http://ww2.odu.edu/~jadam/docs/rainbow\\_glorie\\_review.pdf](http://ww2.odu.edu/~jadam/docs/rainbow_glorie_review.pdf). John A. Adam, Physics Reports 356 (2002) p. 229-365.
- o All about rainbows, double rainbows, circular rainbows! <https://skullsinthestars.com/2013/05/13/all-about-rainbows-double-rainbows-circular-rainbows/>. Skulls in the Stars.
- o Rainbow. <http://hyperphysics.phy-astr.gsu.edu/hbase/atmos/rbownpri.html>. Hyperphysics.
- o Greenler, Robert. Rainbows, Halos and Glories. Cambridge Univ. Press, 1980.

**Feedback is appreciated from readers.  
E-mail [dsimanek@lhup.edu](mailto:dsimanek@lhup.edu).**

# A Physicist's Best Friend: **A Fur-mi Problem**

by Brad R. Conrad, PhD, Director of SPS & Sigma Pi Sigma

**Answering back-of-the-envelope questions is a skill taught in many physics departments around the US. These order-of-magnitude problems are named after Enrico Fermi, who would famously ask his introductory course students a question that could not easily be looked up. This issue's example is pawstively impossible to find in a textbook: How many sleeping cats are there in the US today?**

## SOLUTION:

This problem is a good one because you could approach it from a few points of view. Whenever you approach a back-of-the-envelope question, you first need to decide on what you need to know to answer the question.

For this case, I want to know:

- How many cats live in the US?
- What are the odds any given cat is sleeping?

And if I multiply the answer to (a) and (b), I should get a good estimate.

I'll start off by making an estimate about how often cats are sleeping, because it's the easier of the two. For those of us that have had the pleasure of living with a cat, the answer may seem to be "all the time," but that's not really the case. I'm going to go with a safe guess of 16 hours a day. I say 16 is a safe guess because it's in the right ballpark when you think about orders of magnitude and the range that could be the actual answer. Cats definitely sleep more than two hours a day, since most things do! It's also a safe bet that they sleep more than four or even eight hours a day as well. On the other end of the spectrum, the most a cat can sleep in one day is 24 hours, which we know is too high. So, the actual answer is between 8 and 24, which averages to 16. Worst-case scenario, we are off by a factor of 2. That means if you were to measure an infinite number of identical cats in identical states, a so-called ensemble of cats, you'd find about 16/24, or two-thirds of them to be asleep. Thus, b) is about 2/3.

The first part is a bit more challenging to estimate than the second because we have to make some big assumptions. To answer how many cats live in the US, we need to add together the pet cat population and the stray population. I remember that there are about 320 million people in the US, and my guess is that, on average, one out of four people own one cat. That means there are about 80 million cats, or 80 Mcat (where M means mega, or  $10^6$ ). It's much harder to guess how many strays live in the US, or how one would even count those cats. But, for the sake of the problem, let's estimate there are  $\frac{1}{2}$  as many stray cats as pet cats. I make this guess (and it's not a very good one) based on how

many cat owners I know who got their cat through adoption. Sometimes you have to go with what you know. Thus the total number of cats is:

$$80 \text{ Mcats} + \frac{1}{2} \cdot 80 \text{ Mcats} = \frac{3}{2} \cdot 80 \text{ Mcat} = 120 \text{ Mcat}$$

And since we already determined that there was a 2/3 probability a cat is asleep at any given time, we are left with 80 Mcat, or 80 million cats.

Are we right? I have no idea! I would also argue that while we might be able to count the number of pet cats, it's very hard to know the number of stray cats. That being said, the actual answer is unlikely to be less than 40 million or more than 160 million cats, unless one of my assumptions is very wrong—where very means off by more than a factor of 2.

We may not ever be able to get the "true" answer (because surveying every cat in the country to see if it is asleep would be prohibitively expensive), but I can look up some statistics and infer a solution.

According to the ASPCA, the US has about 3.2 million cats in shelters nationwide, and there are approximately 86 million owned cats in the US.<sup>1</sup> Upon searching, the number of stray cats varies wildly, but some sources cite experts that claim around 70 million.<sup>2</sup> We also need to know how much cats sleep, which according to some research is about 13.2 hours.<sup>3</sup>

Thus, combining the known results:

$$(86 \text{ Mcats} + 70 \text{ Mcats}) \cdot \frac{13.2 \text{ hours}}{24.0 \text{ hours}} \cong 86 \text{ Mcat}$$

which is surprisingly close to our back-of-the-envelope solution of 80 Mcats. (P)awesome! //

**Have a good idea for the next Fermi problem? Send it to [spss@aip.org](mailto:spss@aip.org) with the subject line "Fermi problems."**

1. <https://www.aspc.org/animal-homelessness/shelter-intake-and-surrender/pet-statistics>.

2. [http://news.nationalgeographic.com/news/2004/09/0907\\_040907\\_feral-cats.html](http://news.nationalgeographic.com/news/2004/09/0907_040907_feral-cats.html).

3. S. Campbell and I. Tobler, Animal sleep: A review of sleep duration across phylogeny, *Neurosci. Biobehav. Rev.*, Vol. 8, Issue 3, Autumn 1984, pp. 269-300, <http://dx.doi.org/10.1016/j.cub.2008.06.033>.



## ZONE 18 MEETING:

STUDENTS GATHER AT UC MERCED

by Jacob Parker, SPS Member,  
University of California, Merced

The spring 2017 Zone 18 Meeting was held at the University of California, Merced and was attended by students from several surrounding schools. Over the two days of the meeting, the students listened to inspiring talks, toured physics research labs, made new friends, and had loads of fun.

The meeting kicked off with a lunch where the visiting undergraduate students socialized and talked about their physics experiences and interests with UC Merced students and physics professors. After getting to know each other, the students headed to a talk by Dr. Tom Ramos titled “A History of LLNL Weapons Programs.” The talk gave an informative and personal perspective on how Lawrence Livermore National Labs

(LLNL) significantly influenced the development of early atomic weapons in the United States and the impacts of these developments on World War II and the Cold War. Furthermore, Dr. Ramos inspired students to pursue higher degrees and participate in research at national labs.

Following the talk, students toured either Michael Scheibner’s physics research lab, which focuses on quantum dot systems, or Raymond Chiao’s lab at Castle Air Force Base, which focuses on gravitational wave detection. The tours included exciting discussions on current projects in the labs, what life in a lab is like, and the state of the experimental setups. Once the lab tours concluded, the day ended with a get-together at a local SPS member’s house for pizza and a movie!

The second day of the meeting launched with a breakfast, a tour of the UC Merced science and engineering buildings, and an impromptu walkthrough of Jennifer Lu’s nanomaterials research lab. Following the brief tours, the students gathered for another talk, this time by Dr. Roland Winston. Dr. Winston discussed his current research on solar heat production and encouraged students to be collaborative as they do research.

Next, a panel of eight physics graduate students from UC Merced answered questions about grad school. They also gave personal insight on their own paths to graduate school.

The meeting came to a close on a fun and interactive note by playing Physics Jeopardy. The students split up into three teams and competed to conquer diverse categories such as quantum mechanics, classical mechanics, electrodynamics, thermodynamics, and a “random” category, which threw in interesting and refreshing questions. The game tested teams’ knowledge of physics and was an exceptional way to conclude the meeting.

We had a great time hosting the SPS Zone 18 Meeting—it was a great way to meet many fellow Zone 18 members and a fantastic way to make new friends! //

## ZONE 13 MEETING:

SPS HIGHLIGHTS OF THE JOINT SPRING 2017 MEETING OF THE TEXAS SECTIONS OF SPS, AAPT, AND APS

by Joseph Garcia, SPS Member, San Antonio College

The SPS part of the meeting began with pizza and a demonstration of the prototype hydrogen fuel cell car under construction by our Motorsport Team. Afterwards, we saw an astronomy presentation in the planetarium given by Prof. Alfred Alaniz. The presentation covered the major constellations, lunar cycles, and black holes, as well as a thorough description of the conditions for an eclipse of the sun (coming on Aug. 21, 2017). Another highlight was a banquet where we met astronaut Clayton Anderson, who gave a talk on his experiences as an astronaut and how he achieved his goals. All in all, the event was well received, educational, and inspiring. //



TOP: The UC Merced SPS chapter. Photo by Leo Alonso Cabrera.

BOTTOM: Zone 13 meeting attendees mingle at the opening social. Photo by Gerardo Silva.

# Sea and Sun and Physics!

The XXXI International Conference of Physics Students, August 11-17, 2016, held in Msida on the island of Malta.

by Angela Ludvigsen, University of Wisconsin, River Falls, Class of 2016

**The International Conference of Physics Students (ICPS) is sponsored by the International Association of Physics Students (IAPS) with the goal of collaboration on and discussion of current issues in science. The Society of Physics Students sponsors a competition which helps two students attend this annual conference. I won the SPS Award for Outstanding Undergraduate Research and was honored to be chosen by SPS to represent our country. Louis Varriano, University of Tennessee, Knoxville Class of 2017, was the other student chosen (pictured below).**

I arrived on the beautiful island of Malta, located in the Mediterranean Sea near the coast of Italy, on the first day of the conference and immediately was immersed in opportunities to meet physicists from around the world. The University of Malta in Msida hosted the event and more than 350 students from many different countries were in attendance. Multiple languages were being spoken, but energy and enthusiasm was common to everyone. Most attendees were graduate students, ready to practice presenting their research and to support fellow physics students.

*It was interesting and inspiring to meet so many international students interested in the same subjects as me,*

*AND, HOPEFULLY, I WILL GET THE CHANCE TO COLLABORATE WITH SOME OF THEM IN THE FUTURE.*

*– Louis Varriano, University of Tennessee, Knoxville*

There were ten scheduled times throughout the conference for students to present research, with 10–12 presentations made during each session. There was a rich array of research offered, and it was difficult to choose which of the lectures to attend. Research in materials was heavily represented, followed by astro- and cosmology, atomic, particle, and quantum physics. Also well represented were data analysis and simulation, medical physics, planetary astronomy, nuclear physics, geophysics, and electromagnetism. There were also lectures in physics philosophy.

I presented my research, titled, “Laser Power Effects on the Size of an Optically Trapped Aerosol Droplet Determined Via Whispering Gallery Modes.” Using Raman spectroscopy, I had examined the location and spacing of peaks related to the diameter and the optical properties of an aerosol droplet. For specific ratios of the radius and laser wavelength, the light on the droplet creates a resonance about its circumference. My research goal was to investigate

**BELOW:** Angela Ludvigsen on the island of Gozo in the Maltese Archipelago. Photo courtesy of Angela Ludvigsen.

**LEFT:** Louis Varriano in front of his poster presentation at ICPS. Photo courtesy of Louis Varriano.





and analyze the motion of the droplet to determine how motion relates to a droplet's size variations and resonance with the laser beam. My presentation went well. I was delighted to have participants tell me many times afterward that SPS students are always well prepared.

In addition to student research presentations, there were also workshops. One workshop addressed connecting all levels of students with science worldwide through the Gateway 2 Science portal. Over a million student, instructor, and professional profiles are expected to be hosted on the platform, allowing connections for collaboration and for sharing research. Another workshop focused on improving communication skills for scientists.

There were five guest lectures by physicists. In one, Prof. Mark McCaughrean spoke about the European Space Agency's Rosetta mission: to find the target comet, Comet 67P/Churyumov-Gerasimenko, after a 10-year journey and send the lander Philae down to its surface. Philae landed badly and went silent for a time, but awakened when the comet passed close to the sun. McCaughrean emphasized the importance of setting aggressive goals and working hard to accomplish them. Even if something goes wrong, there will be something you can learn.

My accent was a giveaway that I am American, and I had many opportunities to talk about my physics experiences and life in the United States. This was also a great opportunity to share information about the Society of Physics Students National Council projects. SPS had sent me a box of swag to share with conference participants. Included were little kits to make airplanes, diffraction glasses (huge hit!), bookmarks, and loads of *Radiations* and *Observer* magazines to share. Since we shared housing with the IAPS Executive Committee, Louis and I took advantage of the many opportunities to talk about SPS and strengthen ties between IAPS and SPS.

Each evening there were social opportunities to meet other physicists. My favorite was Nation's Night, which invited students to prepare and share a dish from their country. After we discovered that people were unfamiliar with marshmallows, Louis

European students were amazed  
that it takes me 6 hours to  
drive home from my university,

WHEN IT'S POSSIBLE TO DRIVE FROM CAPITAL  
TO CAPITAL IN LESS TIME IN EUROPE.

— Louis Varriano, University of Tennessee, Knoxville

and I decided s'mores were in order. We visited the local market and purchased "American-style BBQ mallows" and chocolate. We searched in vain for graham crackers—they were not to be

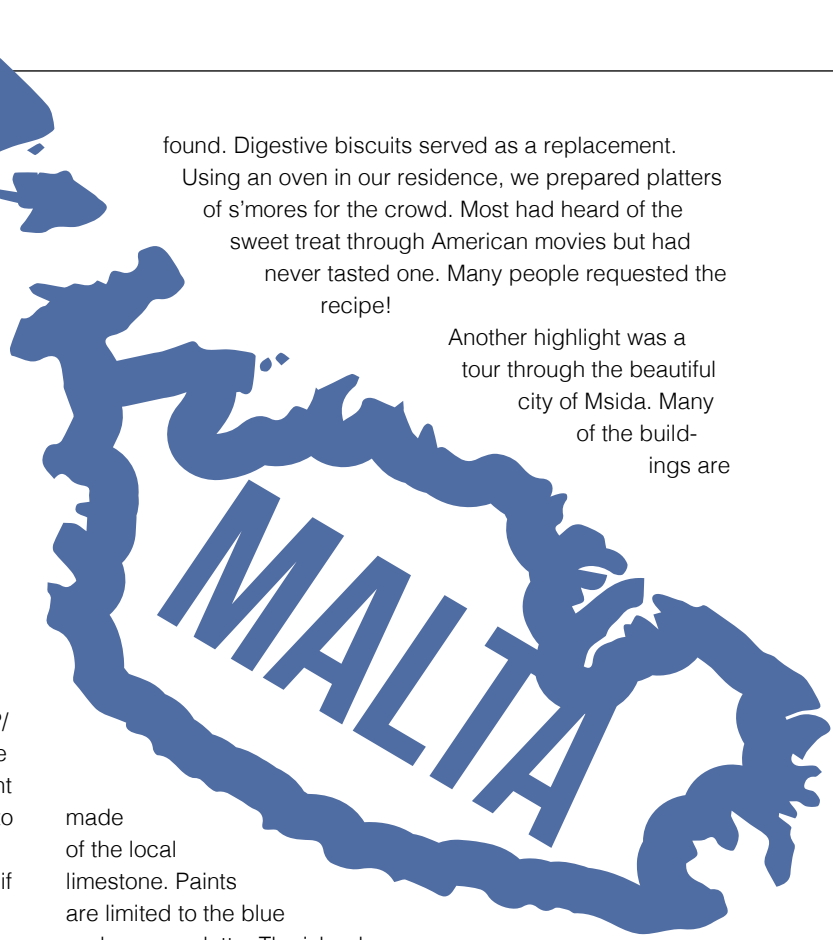
found. Digestive biscuits served as a replacement. Using an oven in our residence, we prepared platters of s'mores for the crowd. Most had heard of the sweet treat through American movies but had never tasted one. Many people requested the recipe!

Another highlight was a tour through the beautiful city of Msida. Many of the buildings are

made of the local limestone. Paints are limited to the blue and green palette. The islands of Malta boast enough beautiful old churches to visit a different one every day of the year and enough festivals for every weekend in the summer.

Participants had opportunities to select from a list of special excursions. The choices ranged from cultural options, like museums or archaeological excavations, to scientific labs, like the Maltese Meteorological Office at the Malta International Airport, the Metrology Directorate where measurements are calibrated, the Life Sciences Park, Sentech Malta FP where fiber optic gyroscopes are made, the Diagnostic Science Laboratories, or the Mepa-Zejtun Air Quality Station. We could also learn about the manufacture of sensors and switches at Methode Electronics, tour the Cisk Brewery, or go sea kayaking. I chose the Diagnostic Science Laboratories, where the restoration and conservation of valuable artwork, architecture, and monuments takes place. When preventing further deterioration of a piece, extensive research is conducted into the artist's techniques and how the environmental conditions where the piece is displayed may affect the art. The lab is adept at detecting forgeries and alterations to works of art. The laboratory is charged with preserving the many cultural treasures and heritage sites in Malta.

It was an honor to represent SPS and the United States at the XXXI International Conference of Physics Students. I enjoyed this opportunity to present my undergraduate research. Being a part of the ICPS 2016 conference gave me a fantastic opportunity to connect with physics students from around the world, learn about new areas of physics, explore a different culture, try new foods, and experience a beautiful part of the world. The 2017 conference will be in Turin, Italy. Hope to see you there! //







# Share your SPS Activities

From doing research to spreading the wonders of physics, local chapters are the heart of SPS activities. Submitting an annual chapter report is the prime opportunity to showcase the activities of your chapter, and preparing the report can play an important role in your chapter activities. How?

Reflecting on the year's events and preparing a report is important for the health, success, and growth of your chapter. By looking back on your year, you will remember accomplishments to celebrate and traditions to keep for next year, and may also see areas for improvement.

Providing up-to-date chapter information ensures that your chapter will receive materials and communication from the SPS National Office next year.

Showcasing your events and accomplishments enables your chapter to be nationally recognized for its great work! Chapters that submit an annual report by June 15, 2017, will be considered for the SPS Outstanding Chapter Award. Your chapter activities may also be featured in one of the SPS publications or on the SPS website.

**FOR DETAILS ON SUBMITTING AN ANNUAL REPORT, SEE:**

[www.spsnational.org/resources/chapters/annual-chapter-reports](http://www.spsnational.org/resources/chapters/annual-chapter-reports)

We look forward to hearing from you!