the SPS Observer

Volume L, Issue 3
Fall 2016

REACHING OUT:
WHO CAN YOU INSPIRE?

+ PHYSCON PREVIEW

SOCIETY OF PHYSICS STUDENTS

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TABLE OF CONTENTS

FALL 2016 ▪ VOLUME L, ISSUE 3

FEATURES

Reaching Out: Who can you inspire?

- The Art of the Game 16
- Backstage at the Big Top 18
- Science for All: A conversation with Dr. Brian Greene 20
- Comic Book Physics: Enlightening science for all 24
- OSA Student Chapters Celebrate The Optical Society's Centennial 26

PhysCon Preview

- Congress is Coming 28
- Dame Jocelyn Bell Burnell: No asking, just telling 30
- For Patrick Brady, LIGO's Success Is Just the Beginning . . . 32
- Eric Cornell and His Cool Condensate 34
- Persis Drell Keeps Asking the Big Questions 36
- The Universe According to Jim Gates. 38
- Neil Turok on Investigating the "Unpopular" 40

DEPARTMENTS

LETTER
Discovery and Innovation: There's so much fun to be had . . . 05

PATHWAYS
An Outreach Adventure 07

STARS
New Application Deadlines 09

PHYSICS PUZZLER
Loopy Physics 10

INTERACTIONS
"Science Fridays" Get a Little More Fun 12
Inspiring Future Scientists 13

SINGULARITIES
Snappy Physics: My internship in byte-sized pieces 42
Meet the 2016 SPS Summer Interns 43

MEETING NOTES
How the APS March Meeting Influenced Me. 44
Journey to the First SPS Chapter in India 45

IN THE ZONE
Regional SPS Highlights 46

ON THE COVER
Kids of all ages searched the skies at *Saturday Night Lights: Stargazing in Brooklyn Bridge Park*, part of a recent World Science Festival. See "Science for All: A Conversation with Dr. Brian Greene," on p. 20.

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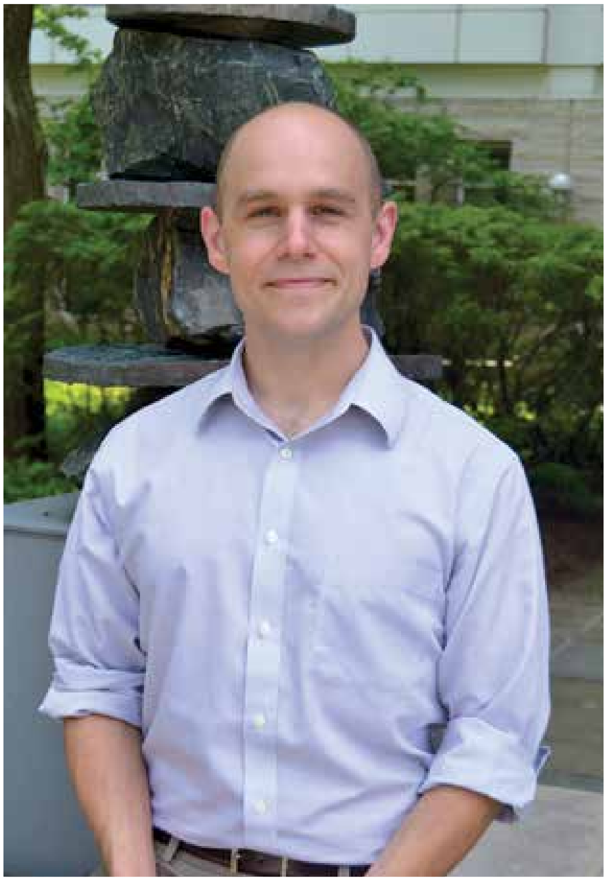
Discovery and Innovation:
There's so much fun to be had

by Brad R. Conrad, Ph.D.
Director of the Society of Physics Students and Sigma Pi Sigma

Welcome to another year of discovery and innovation! For me, the persona of the inventor, the tinkerer, and the explorer are all wrapped up into what it means to be a physicist. Relatively speaking, there aren't that many of us, but we are all trained in such a way that problem solving is of utmost importance. What's important is not necessarily the answer, but rather the way in which we think and reason and approximate to get a handle on the problem.

The world is a messy place, full of messy approximations and assumptions that we know are not true. Cows aren't spherical, friction exists, and there is usually air resistance, yet we can send people to the moon and smash particles together at near the speed of light. Marie Curie and Richard Feynman are famous not only for being able to simplify some of the most complex concepts in physics, but also for their insights about the field and passion for discovery. For example, Feynman was among the best at finding conceptually simple ways of solving very complex problems, as his lectures illustrate.[1] Feynman diagrams are used to this day by theoretical physicists across many fields to represent complex mathematical expressions, even though they were originally a quantum electrodynamics calculation shorthand.[2]



SPS DIRECTOR BRAD R. CONRAD. Photo by Matt Payne.

Throughout your career, you'll be asked to solve problems no one has ever solved before, make instruments from junk laying around the lab, or determine how to do something everyone says is impossible. Physicists don't learn how to solve a set of problems, but how to try to understand a very complex world.

This is why I am proud to call myself a physicist well before any other label. And as a physicist, it is with great pride and a sense of duty that I chose to accept the position of director of the Society of Physics Students and Sigma Pi Sigma this summer.

SPS has been a part of my story since I first started college. For as long as I, or anyone else, can remember, I have wanted to be a scientist. Yet, I can honestly say that half of the reason I chose to stay in physics is my local SPS chapter at the Rochester Institute of Technology. As a first-year student, I was in a small department with only a handful of other physics majors. It was easy to feel lonely. I felt what anyone in my situation—unprepared, put to a great challenge without support—would have felt: that physics was somewhere between daunting and nearly impossible. I was frustrated and overwhelmed, and I felt as if I was the only person feeling this way. I felt like I wasn't good enough and that I was just faking it. Then I went to my first SPS meeting and realized I wasn't alone, that it was okay to be challenged, and that there were lots of other people just like me. I found my respite in a world full of unknowns and challenges. It was through a physics intramural soccer team called h-Bar (ħ), the bad physics movie nights, and the all-night GRE study sessions that I found my home. SPS also gave me back the sense of wonder and excitement that is nicely encapsulated by this quote of Richard Feynman: "I think I've got the right idea, to do crazy things—what other people would consider crazy things. There's so much fun to be had."[3]

We are a small group, but there are amazing people in the physics community. Many of them are passionate and complex and wonderful in ways only physicists can be. It's through the time spent in SPS clubs, interacting with the public at community outreach events, and talking to physicists of all ages that we make the connections that make us

IT IS ON THIS NOTE THAT I ASK YOU TO EMBRACE THE TITLE OF PHYSICIST AND MAKE IT YOUR OWN.

Change the world.
Solve unsolvable problems.
Tinker in the lab.
Make crazy inventions.

AND, MOST IMPORTANTLY, DO IT WITH OTHERS.

a community. For me, giving back to the community has made every late-night study session, last-minute homework epiphany, and every stressful final worth it. My only hope is that one day I'm able to give back more than I received.

And that's part of the reason I wanted to introduce myself to you. I'm here at the SPS National Office to *help* each of you make SPS something special for you and for every physics and astronomy major. I stress the word *help* because there is no way I can do it alone. There is no way the team here at the SPS National Office can do it all. This organization is really yours and what you make it, and I ask you today to help your fellow physics enthusiasts. Tinker. Invent. Discover. Don't do it alone. The only reason I'm here today is because people cared and helped me through those very tumultuous times. Please help me try to help every physics student.

There aren't that many of us, but there sure is so much fun to be had.

Sincerely,
Brad R. Conrad, Ph.D.
Director of the Society of Physics Students and Sigma Pi Sigma

P.S. The other half of the reason, for those keeping track, was a tag-team effort of my professors, Anne Young and John Andersen. Without their friendship and fellowship, I wouldn't be who I am today. //

1. R. Feynman, R. Leighton, and M. Sands, *The Feynman Lectures on Physics*, 3 volumes (1963 and 1965).
2. D. Kaiser, *Physics and Feynman's Diagrams*, Am. Sci. 9, 156 (2005).
3. R. Feynman, *No Ordinary Genius: The Illustrated Richard Feynman*, p. 89 (W. W. Norton & Co., New York,1996).

An Outreach Adventure

A SUCCESSFUL EVENT THAT DIDN'T GO AS PLANNED

by Tonya Coffey

I have always loved science outreach, especially when it is with younger children. Their enthusiasm is so exciting to see; it helps me remember why I started studying physics in the first place. But my most successful outreach project didn't go at all like I'd planned.

In the early months of 2010, I was recruited to host events for the North Carolina Science Festival, the first statewide science festival. The organizers wanted Appalachian State University (ASU), where I am a physics professor, to host events so western North Carolina could participate. I met with several faculty on campus who regularly host STEM outreach events. We agreed to host multiple events, including talks, a stargazing event at our Dark Sky Observatory, and a multidisciplinary STEM open house that we called the ASU Science Expo. I agreed to coordinate the Expo.

Our first Expo was not a success. Despite plenty of advertising and cool STEM booths, we only had about 50 attendees over a three-hour period on a Sunday afternoon. I was disappointed. I decided that the following year we would have the Expo on a school day and invite local teachers to bring their 6th–12th grade students on field trips. That way, we'd have a captive audience.

TOP: Tonya Coffey.
BOTTOM: Our Expo is a multidisciplinary event. Here, students identify small fossils.
Photos courtesy of Appalachian State University.

For the next festival, I envisioned teachers bringing their science class of 20 or 30 students. I was aiming for about 200–250 students over four hours. I planned to stagger attendees through the floor by offering activities, tours, and shows around campus. Some of our special events included tours and demos of our advanced microscopes, sungazing at our observatory, a laser show, and hands-on projects.

I sent the first e-mail to the teachers at about 11 a.m. on January 23, 2012. By 5 p.m. of that same day, 350 students were registered for the Expo. I was pleased but surprised, because those 350 students were coming from only two or three schools. When they registered, the teachers signed up all the sixth graders in their school to attend, not just their class. "How wonderful that you're doing this! I've been waiting for Appalachian to do something like this for a long time," one teacher e-mailed. By the end of the second day of registration, 500 students were coming to the Expo. By the end of the first week, it was up to 700. I needed more space, presenters, and money. I needed more everything.

I sent an e-mail to the dean of the College of Arts and Sciences. It started: "Help. This Science Expo is getting out of control…" The e-mail I sent to the chancellor, provost, and my dean on February 9 was more formal, but the panic is still visible: "…I now have 1,100 middle and high school students coming on April 16, and I am turning away all further requests for attendance.…I could use some support with the event's organization."

Within one week I had a new best friend, Tracey Tardiff, from our College Awareness Program. Tracey regularly arranges tours and coordinates large events for the university. We booked Holmes Convocation Center for the Expo floor and hosted the special events around campus. In an event of this size, there are a myriad of tiny details—we had to see to them all.

In the end, we were a big hit! Teachers were already trying to book a spot at the next Expo. It's become normal for us to receive requests over six months in advance. Tracey and I now work with a committee of organizers. I write at least two small grant proposals each year to fund the Expo, and attendance is now capped at roughly 2,500 students. We have around 40 booths and more than a dozen special events from more than 20 different academic departments, with roughly 150 volunteers from our faculty, staff, and students. Following national trends in education, we've gone from a STEM Expo to a STEAM Expo (the A stands for arts). Through it all, though, the heart of the event has remained the same: to excite students about learning science.

GETTING INVOLVED—SOME TIPS

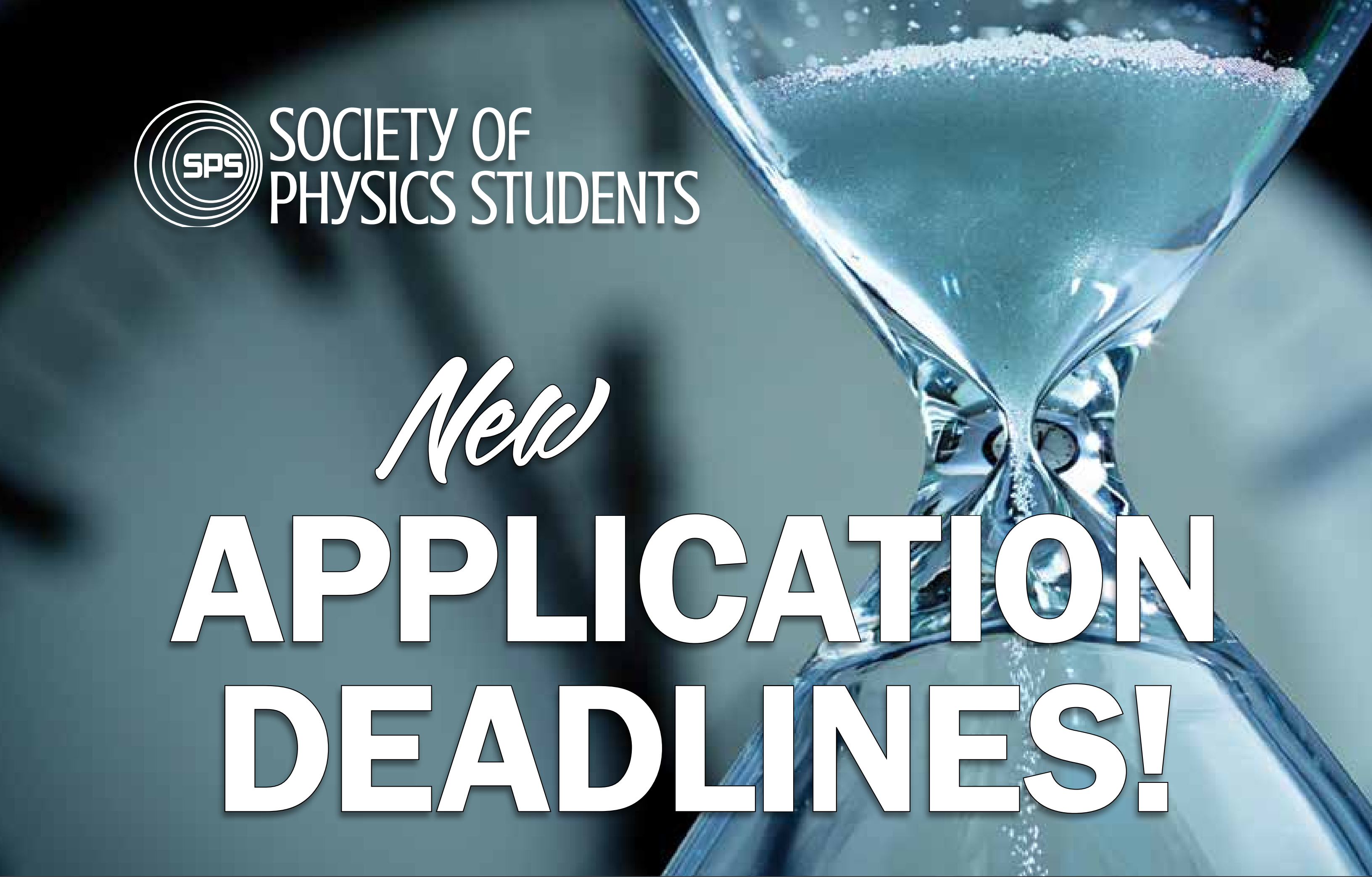
If my story didn't scare you too much and you're still interested in outreach, ask around and get involved.

- Most colleges and universities have existing outreach programs that could really use your help.
- If there's no existing outreach program, just contact the principal of a local public school. They love to have visiting scientists work with their students.
- If you have to design your own content, know your audience. What you present to a 2nd grader is not the same as what you would present to a high school student.
- Demo shows are wonderful, and everyone loves them. But if you really want the audience to learn, hands-on activities or something more interactive is a superior approach.
- The best advice I can give is this: Know when to ask for help! //

HANDS-ON ACTIVITIES ARE MORE MEMORABLE than simple displays or demo shows, and should be incorporated into outreach whenever possible. Photo courtesy of Appalachian State University.

DIG DEEPER

See p. 19 for more outreach ideas.



Mark your calendars!

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

FALL DEADLINE: November 15

- Sigma Pi Sigma Chapter Project Award
- Future Faces of Physics Award
- SPS Chapter Research Award
- Marsh W. White Award

WINTER DEADLINE: January 15

- SPS Internships

SPRING DEADLINE: March 15

- Outstanding Chapter Advisor Award
- SPS Award for Outstanding Undergraduate Research
- SPS Scholarships

SUMMER DEADLINE: June 15

- Chapter Reports
- Blake Lilly Prize

ONGOING OPPORTUNITIES:

- SPS Travel Awards
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AIP American Institute of Physics

Loopy Physics | CELESTIAL TEXTBOOK MISCONCEPTIONS

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

Our closest celestial neighbor, the Moon, presents two puzzles for your consideration.

Puzzles

01 Physics textbooks are lavishly illustrated, which is one reason they cost so much. But illustrations can mislead. Here's one from a 1997 book by a major university publisher. The accompanying description reads:

...both the Earth and the moon are in nearly circular orbits about the sun. They perturb each other's orbits—viewed from the sun, the moon performs a tiny "rosette" about the Earth's orbit (see Figure 1).

Even text can mislead. You can see why we do not credit the source, for the authors and publisher would likely rather remain anonymous. What is wrong with this diagram and this text? (There may be several errors.) How should these be corrected?

02 Standing on the Earth at the equator, are you closer to the Sun at high noon at the time of new moon, or at high noon a half-month later at the time of full moon? Why?

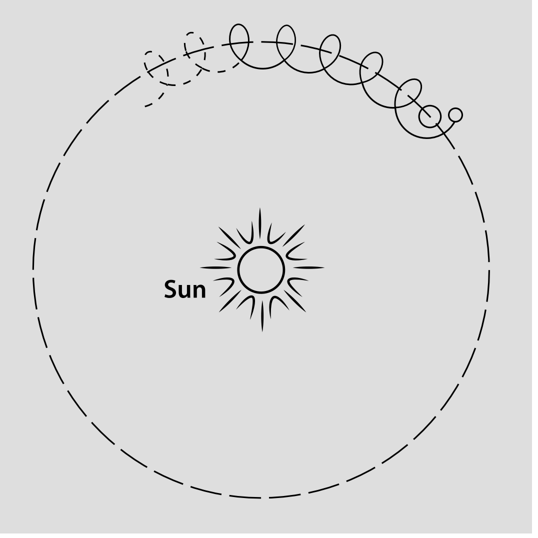


FIG. 1. Path of Earth and Moon?

Answers

01 The Moon orbits Earth once every 29.53 days with respect to the Sun (which is called the synodic period). So it makes only about 12.4 orbits in a year. Figure 1 suggests many more orbits than that.

Figure 1 is clearly not to scale. The loops are much too large for the Moon's orbit around the Earth. But does the Moon actually make such a loopy path, crossing itself every month?

In fact, the Moon's path never crosses itself, so the description of its path as a "rosette" is clearly misleading. The true path, to scale, looks like this:

FIG. 2. Earth and Moon paths to scale. Their sizes are not to the same scale. (From Wikipedia.)

Textbooks and popular science publications ought to more liberally use the picture caption disclaimer "Not to scale." But scale isn't the only problem here.

The striking thing about the Moon's true path around the Sun is that it is nearly circular, never crosses itself, and is always concave toward the Sun. Earth and the Moon both orbit the Sun in nearly the same path as they swing around their common center of mass, like a pair of gracefully whirling ice dancers. The center of mass of the Earth-Moon system (the barycenter) is within the body of the Earth, at a distance of 4,671 km away from Earth's center. Remember that Earth's radius is 6,378 km. The barycenter makes an elliptical—but still near-circular—orbit around the Sun. The Earth and Moon both orbit the barycenter. Neither path is loopy. They are both near circular.

This book got one thing right. It says "...both the Earth and the moon are in nearly circular orbits about the sun." Unfortunately, the authors went astray in the rest of their explanation, and the artist who drew the picture didn't get the correct message.

02 The barycenter is again important here. The Earth is closer to the Sun at full moon. At noon at full moon, the center of the Earth is $2 \times 4{,}671 = 9{,}342$ km closer to the Sun than it is at noon at new moon. So you are also that much closer to the Sun at noon at the time of new moon.

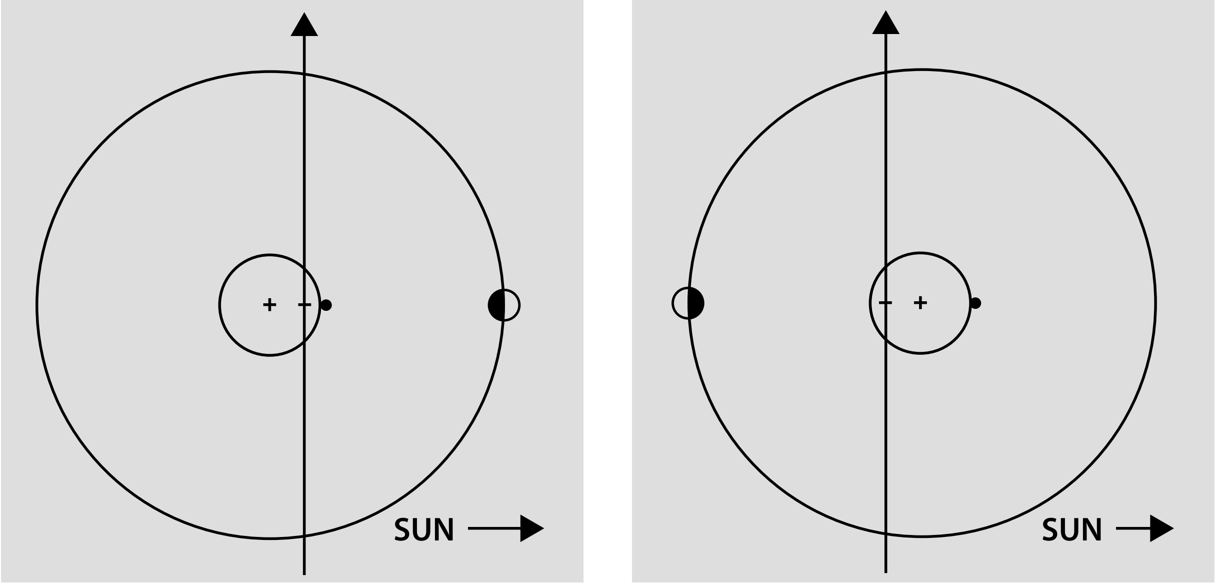


FIG. 3. Positions of Earth and Moon at time of new moon (left) and full moon (right). + is the center of Earth. - is the Earth-Moon barycenter. The black dot is an observer at noon on the equator. Schematic. Not to scale.

The Earth's axis is tilted with respect to the Earth's orbital plane, and the Moon's orbital plane is also tilted (and also eccentric), so your distance from the Sun depends on where on the Earth you are standing and the Moon's position in its orbit at that time. We didn't ask for a quantitative answer. You are welcome to puzzle that out. Nor will we speculate how much sooner you would get a tan lying on the beach at noon when the Moon is full.

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

"Science Fridays"
Get a Little More Fun

by Nathan Prins, Towson University

Towson University SPS members and the Hampden Family Center in Baltimore, Maryland, joined forces in January to create a more engaging activity for elementary school students in the Family Center's after-school program. While the Hampden Family Center had previously run "Science Friday," we really wanted to make sure the kids had fun in addition to learning physics. We came up with lots of activities for the kids to do, such as making Oobleck, tracking projectiles, and hoverboarding. Each week the kids explored science and learned some new vocabulary words—in fact, after the first day, the program manager said this was the first time in two years that not a single kid asked to do something different than the planned activity. That streak didn't last, but the Family Center managers and coordinators did comment on how engaged and focused the kids had become.

About 20 SPS volunteers have been working with the Family Center, about five each week, and they've also learned more about how to work with kids and what to expect.

The best part? There is overwhelming interest in continuing the program next year! //

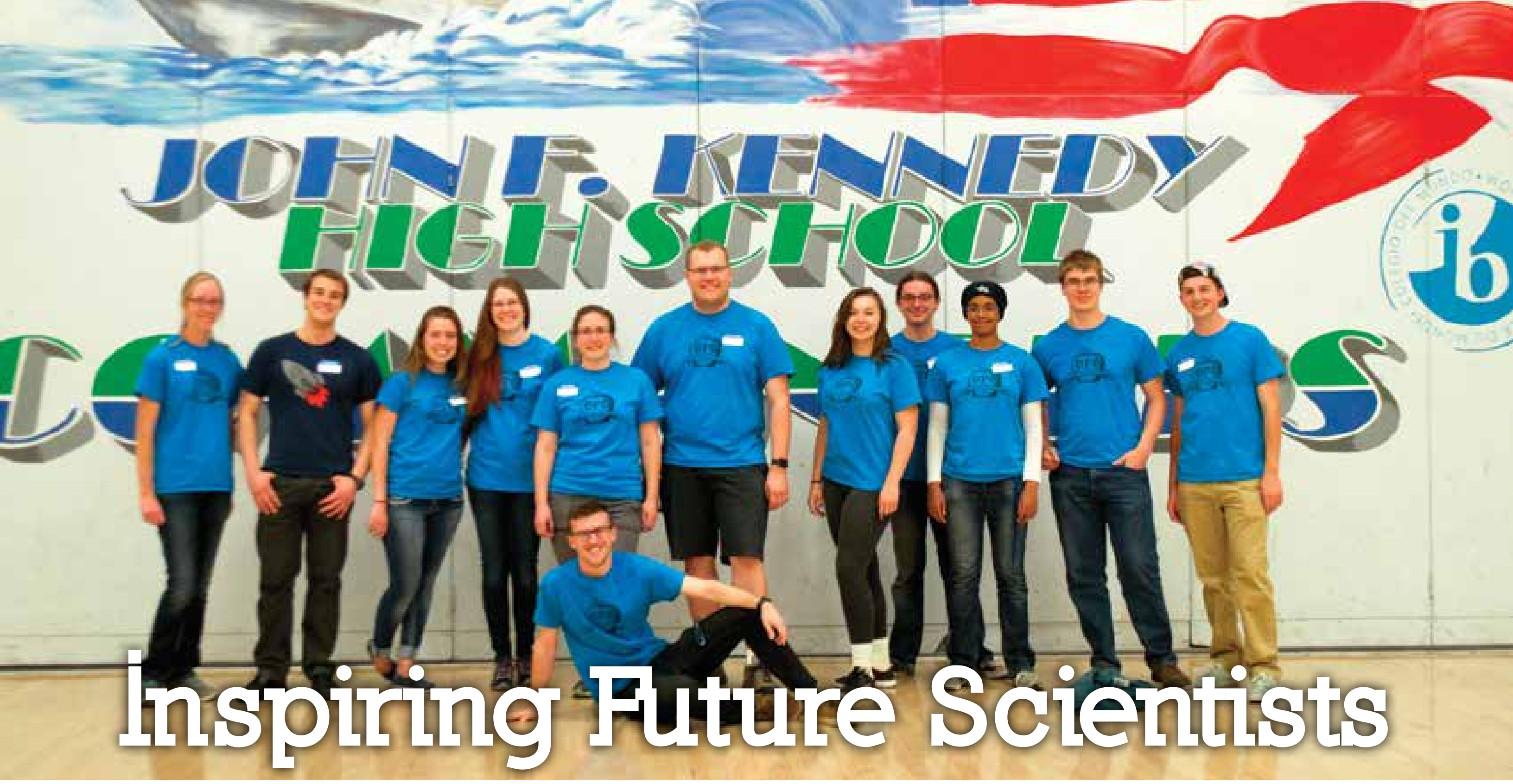
TOP: "Airplane Day'' at the Hampden Family Center Science Friday.

BOTTOM: A Science Friday group making Oobleck. Photos courtesy of Towson State University.

GET FUNDS FOR OUTREACH

Towson's "Science Fridays" project was funded with a 2015 Marsh W. White Award. These awards are given to SPS chapters to support projects that promote interest in physics among students and the general public. Submit *your* project for a 2016 award—details at www.spsnational.org/awards/marsh-white.

Proposals are due November 15.



Inspiring Future Scientists

TOP: The entire Colorado School of Mines volunteer group. Photo by Natalie Dibling.

MIDDLE: Jacob Wikowsky and Lindsey Hart show a student the mini-plasma cutter made from a voltage supply, pencil lead, and aluminum foil. Photo by Allison Tucker.

BOTTOM: Allison Tucker and Nick Smith explain Lenz's law and the ideas of eddy currents to a group of students. Photo by Fran Mallett.

by David Schmidt, Colorado School of Mines

Every year, the SPS chapter at the Colorado School of Mines does a series of science demonstrations for a nearby high school. This year we received a SPS Future Faces of Physics Award, which allowed us to go to John F. Kennedy High School, a school in a mainly low-income Hispanic community with a poorly funded science department. Our goals were to showcase science in a fun environment and serve as role models for students interested in studying and pursuing careers in physics.

We set up five demo stations for students to learn about different types of physics. We made a mini plasma cutter that sliced through foil, visualized sound waves with a Chladni plate, and more.

We reached about 100 juniors and seniors in high school, many of whom do not have family members with secondary education but who are intellectually curious about science, math, and college. It was rewarding to talk to the students about science—many of them asked very challenging questions, showing their interest and exploration outside the classroom. Additionally, many asked questions about college and post–high school options.

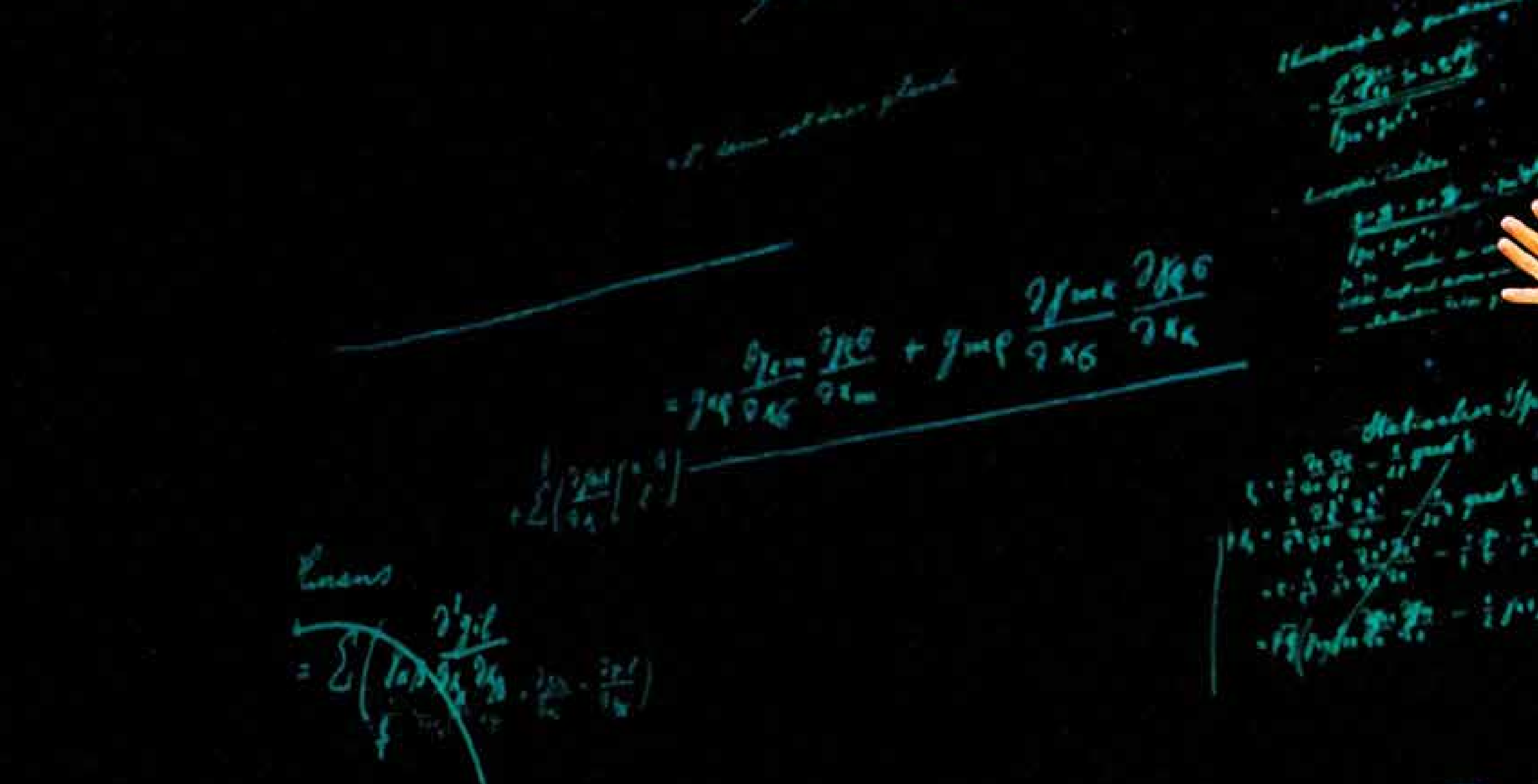
The plan for next year is to go to a different school—as we do every year—but we're glad to have built a relationship with John F. Kennedy High School and its students. //

PROMOTE PHYSICS

Future Faces of Physics Awards of up to $500 are made to SPS chapters to support projects designed to promote physics across cultures. Applications are due November 15. For details, see www.spsnational.org/awards/future-faces.

FEATURE

REACHING OUT: WHO CAN YOU INSPIRE?



At the core of each physicist is a tricky and dangerous question: Why?

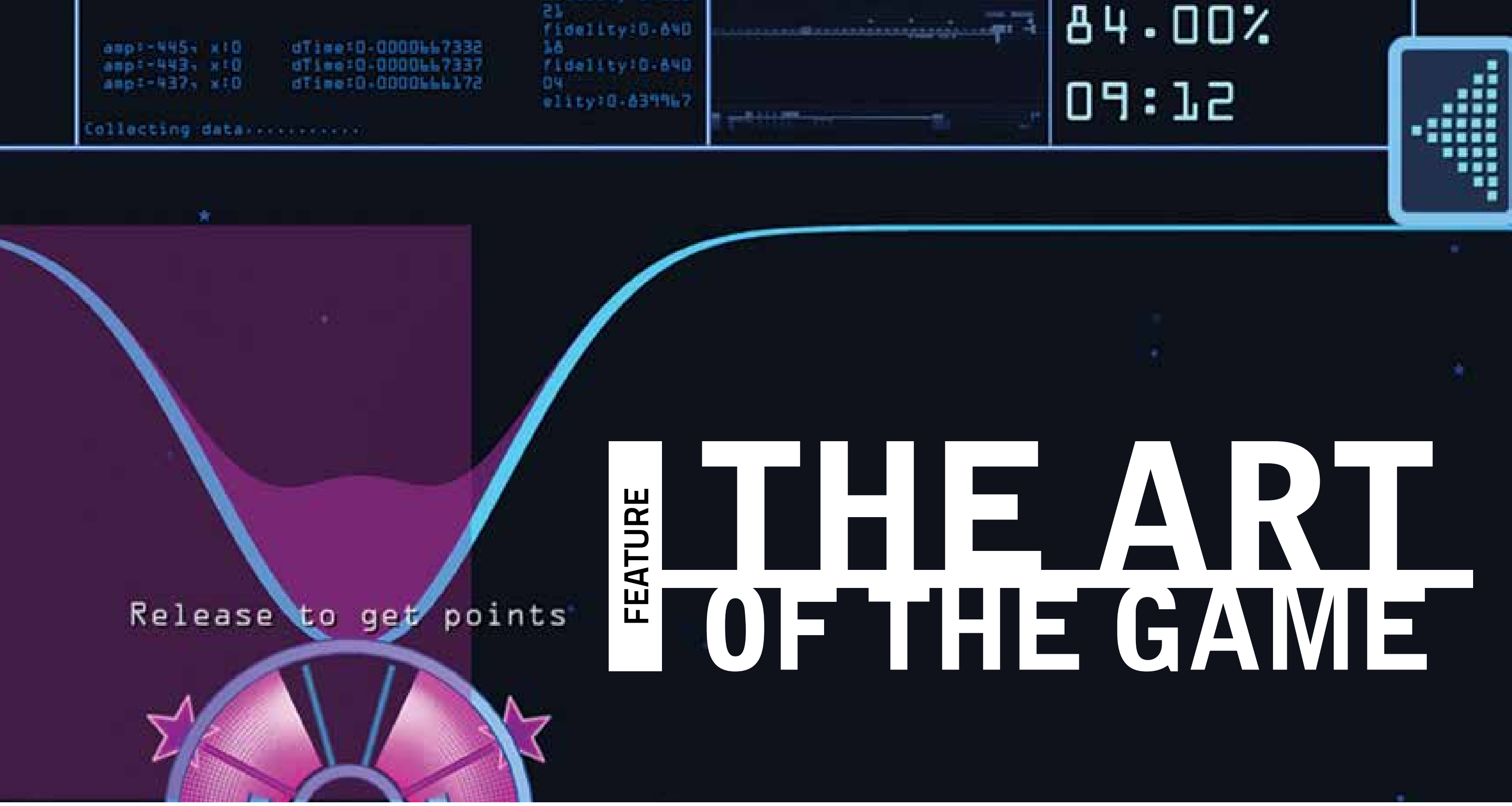
Why does entropy seem to always increase? Why do black holes form? Why does observation collapse a wave function?

"Why?" questions seek to explain the unknown, and this is why they are so fraught with danger and excitement: These questions result in even more questions!

Getting people to explore the world around them and ask, "Why?" is the very essence of outreach. While outreach can take many different forms, as the following features show, each of these highlighted outreach events seeks to inspire. Whether it's the general public, fellow students, or even scientists, the best outreach creates a spark of interest that is never extinguished and results in an even more exciting, "Why?"

Why

ABOVE: Dr. Brian Greene onstage at the World Science Festival in New York City, NY. See the related article on page 20. Photo courtesy of the World Science Festival.



FEATURE

THE ART OF THE GAME

GAMING: PUSHING THE BOUNDARIES OF SCIENTIFIC RESEARCH

by Janet Rafner
Fulbright US Student Programs 2015–16, Niels Bohr Institute, University of Copenhagen, University of Aarhus

Want to push the boundaries of scientific research by playing games? I decided to give it a try when I joined ScienceAtHome (www.scienceathome.org), a large-scale crowdsourcing and citizen-science project based in Aarhus University in Denmark.

Many of the most interesting problems in the scientific community are immensely complex. Often these challenges are too difficult to tackle even for the best scientists and the most powerful computers. But people, including non-scientists, can help find solutions if the problems are properly presented and if they are given the right tools. Specifically, those tools are citizen science and gamification. Citizen science opens the doors of the laboratory and invites people of all backgrounds to contribute to scientific problem-solving on a voluntary basis. Gamification, the process of turning a problem or task into a game, is one of the most important tools for scientists, making their scientific investigations tangible and accessible for the general public. By playing the game "Quantum Moves," people help Aarhus University researchers determine the best process by which to move atoms in a quantum computer.

So how did I get here? How did I join this incredible group of scientists, game developers, designers, and visual artists who create fun games for citizens to contribute to quantum physics, model human thinking, and much more?

Introductions can be transformative. We all have ideas about what we would like to do in our careers, but achieving those ambitions can be daunting. A chance hallway meeting in 2013 with a professor at the University of Virginia's physics building led me, a

JANET RAFNER. Photo by Ola Joensen, University of Copenhagen.

2015 Fulbright Fellow, University of Virginia graduate, and former SPS officer, to pursue the intersection of art and science in Denmark and to a project on the gamification of physics research.

Two years ago, I would never have imagined that I would be splitting my time between the University of Aarhus, which is developing ways to crowdsource research through game play, and science communication projects at the Niels Bohr Institute in Copenhagen.

As an undergraduate, I pursued an unusual mix of physics and studio art, and began volunteering with outreach programs such as National Physics Day and a program that offered middle school girls hands-on physics experiences. As an example, I came up with the idea to teach them how to photograph physics phenomena, such as Chladni plates (to foster an understanding of standing waves), how digital photography works, and how to best light a subject and frame a subject to capture and convey the intended effect. I also became involved in my university's SPS chapter.

One day during this time, I went to office hours, but I didn't go in because I felt a bit intimidated, as many students do. Instead, by chance, I ran into a professor, Lou Bloomfield, in the hallway and we started talking about my interests. Within a few minutes he went online and introduced me to a professor at Paris Sud, who led an outreach project called *Physics Reimagined*, and later set up an internship for me for the summer with funding from both the University of Virginia (UVA) and the French Centre National de la Recherche Scientifique (CNRS). This chance hallway meeting turned out to be vital for my career.

Meanwhile, many of my leadership skills were developed through SPS. As one of our main projects, we started a physics "Big Siblings" program to provide mentorship to underclassmen physics majors or prospective majors. Starting last fall, each participating underclassman was paired with an upperclassman to help with questions about courses, professors, research, etc. The goal of this project was to find a way to provide guidance, advice, and insights regarding being a physics or astrophysics major at UVA. We paid close attention to a mentee's extracurricular activities, minors, or intended double majors and paired them with mentors with similar interests. The other SPS officer, Mita Tembe, and I worked diligently to build the mentorship program. Through this initiative, we hoped to both accelerate research and grow a stronger student community within the physics department.

Helping others through the mentorship program opened my eyes to how important these relationships are for achieving your aspirations. During my internship at Paris Sud, I put everything into it. The head of the group, Professor Julien Bobroff, and the whole team were great to work with. Being immersed in such a creative environment was an amazing experience. They were teaching courses by bringing physics and design students together to explore interdisciplinary projects. A paper on this course format has been accepted for publication in *Nature*.[1] The *Physics Reimagined* effort also embodies a strong facet of physics outreach: informing and shaping the culture of physics so that it is more accessible and engaging to both prospective students and the public. I still feel like I'm part of their extended family and hope to collaborate whenever possible in the future.

Understanding the importance of mentorships has also been crucial to my current Fulbright work. I contribute to diverse scientific and outreach projects by tapping into my motivations, talents, and collaboration skills and bringing the concepts of complex physics into the vernacular.

ABOVE: Students play the Quantum Moves game. Images ©ScienceAtHome. Used with permission.

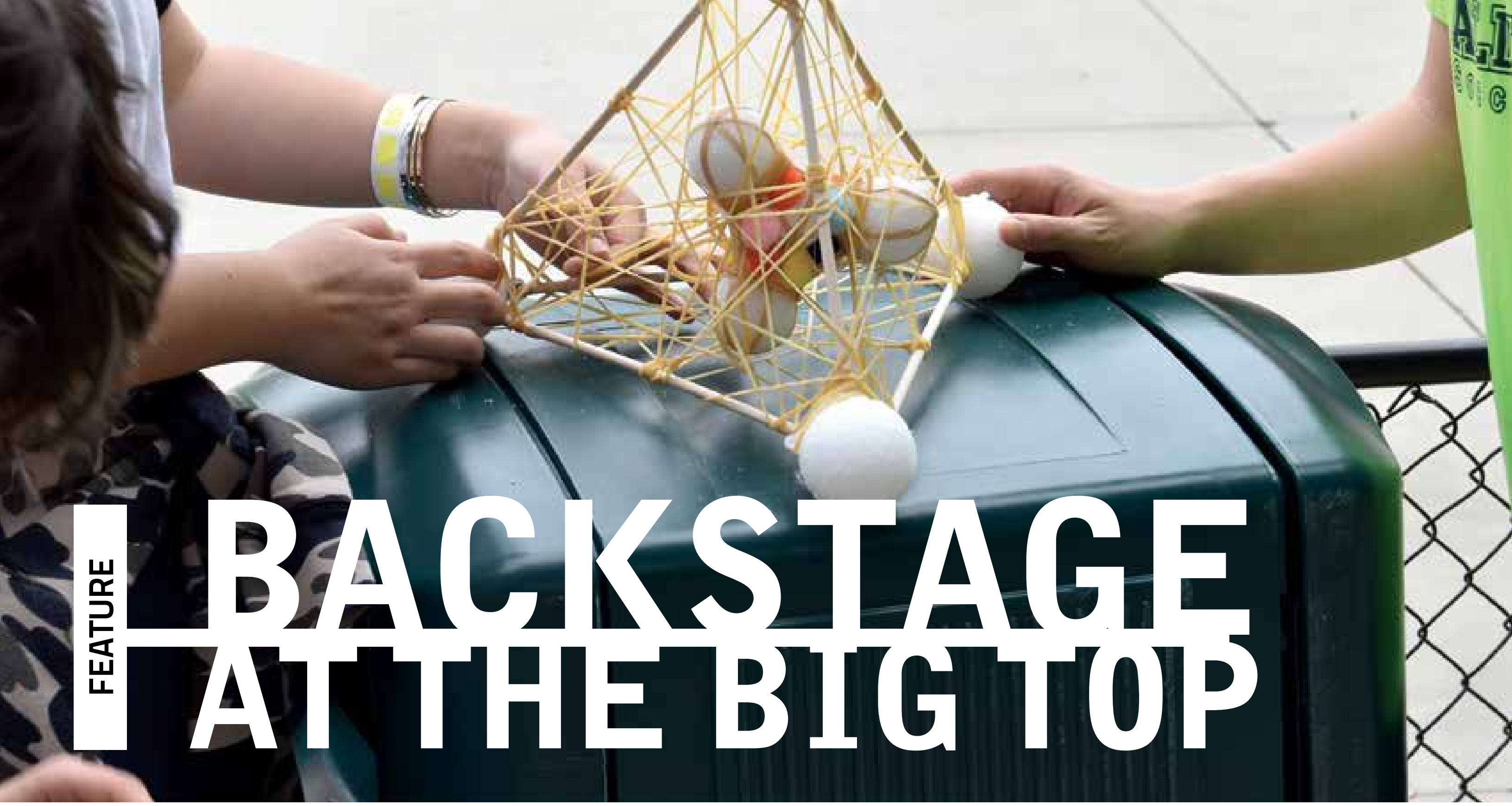
This is an exciting niche field that is just taking off, so for me the future is clearly "game on." Professors Rikke Schmidt-Kjærgaard and Jacob Sherson at Aarhus have made these projects possible—I couldn't ask for more supportive faculty members. I'm looking forward to being a mentor to rising science and design students as I continue to explore how technical tools and artistic creativity can be used to express complex concepts in science and share my findings internationally. //

1. *Nature* 532, 210–213 (2016), "Exploring the Quantum Speed Limit with Computer Games."

GET INVOLVED

Want to join me and play games to help solve complex physics problems? Go to www.scienceathome.org/citizen-science/games.

Two of the ScienceAtHome games, *Quantum Moves* and *Skill Lab*, are available on the App Store for Apple products and the Play Store for Android.



FEATURE

BACKSTAGE AT THE BIG TOP

by Joe York, former Industrial Outreach Manager, American Institute of Physics

The American Institute of Physics (AIP) and partners APS, OSA, ASA, AAPT, ACA, and SPS brought a physics circus to the USA Science and Engineering Festival (USASEF) in Washington, DC, where more than 350,000 attendees swarmed the 1,000+ exhibitors, including the Big Top Physics pavilion. Highlights of this year's collaboration were a bed of nails, a light painting booth, singing pipes, a photo wall, and several smoke cannons.

We also had a great time at the 2016 Six Flags America Physics Day, hosted on April 22 in Upper Marlboro, Maryland. The SPS volunteers, with a big thank you to the Pennsylvania State University volunteers for driving so far to help, along with staff from AAPT, APS, and the SPS National Office, provided regional students the chance to ride a rollercoaster while wearing accelerometers in order to conduct experiments and learn the fundamentals of what makes a rollercoaster "go." There were screams of excitement about science at this year's Six Flags America Physics Day. //

Good public outreach can spark an "AHA!" moment with the participants.

GREAT PUBLIC OUTREACH IS CAPABLE OF INSPIRING INDIVIDUALS AND TEACHING THEM ABOUT SCIENTIFIC CONCEPTS IN A MANNER SUITABLE TO THE INTENDED AUDIENCE.

ABOVE: Joe York of AIP sends smiles throughout the exhibit hall with a smoke cannon at USASEF. Photo by Matt Payne.

Public outreach conducted as a collaborative effort is synergistic in nature —

THAT IS, THE COMBINED EFFECT OF THE PARTNERS IS GREATER THAN THE SUM OF THE INDIVIDUAL IMPACTS EACH COMPONENT COULD MAKE ON ITS OWN. THOSE OF US AT AIP ENJOY WORKING WITH OUR MEMBER SOCIETIES AND OTHER ORGANIZATIONS ON EFFORTS LIKE THESE BECAUSE WE CAN MAKE MORE NOISE, CREATE BIGGER BANGS, AND ENJOY GREATER ENGAGEMENT WITH PEOPLE THROUGH SUCH COLLABORATIONS THAN WE COULD ON OUR OWN—ALL WHILE HAVING FUN, TOO.

Photo by Matt Payne.

ABOVE: SPS volunteers from Pennsylvania State University pose for a photo before Six Flags America Physics Day.

TOP LEFT: Maryland high school students create a device to keep a raw egg intact during the Egg Drop Competition at Six Flags Physics Day.
Photos by Matt Payne.

Public outreach is an excellent way to build professional skills,

SUCH AS PUBLIC SPEAKING, PROBLEM SOLVING, LOGISTICS, AND TIME MANAGEMENT, WHILE AT THE SAME TIME PERFORMING A SERVICE AND HAVING FUN. INSPIRING OTHERS AND SHOWING THEM WHY YOU LOVE BEING A PHYSICIST IS CONTAGIOUS. AS AN ADDED BONUS, YOU WILL FIND YOURSELF WITH A GREATER CONFIDENCE IN THE SUBJECT MATTER.

SOCIETY OF PHYSICS STUDENTS

Check out some of the resources on the SPS National website to help your chapter or group get involved in outreach:

To kick-start your efforts, Science Outreach Catalyst Kits (SOCKs) are available on the SPS website:

www.spsnational.org/programs/outreach/science-outreach-catalyst-kits

The 2016 SPS Summer Interns were a part of several outreach events this summer, including:

- Astronomy Night on the National Mall, facilitated by Hofstra University
- Meet a Nobel Laureate with the Koshland Science Museum
- Women's Policy Inc. STEM Fair
- NIST Summer Institute for Middle School Teachers

We even had one of our interns, Isabel Binamira, work solely on public outreach! Check out her outreach blog posts to see what she has to say about her experience:

www.spsnational.org/programs/internships/2016/isabel-binamira.

Or read her story on page 44 of this magazine.

If you are interested in developing an outreach effort, a demo, or just have questions, we are here to help you! Ask us how to get more involved or to post your outreach adventure.

sps@aip.org

SCIENCE FOR ALL: A CONVERSATION WITH DR. BRIAN GREENE

by Victoria DiTomasso, SPS Summer 2016 Intern

The World Science Festival is a wonderland for science outreach. For seven days each year, New York City is the gathering place of the great minds in science and the arts, all working to produce live and digital content that brings science out of the laboratory and into the streets, parks, museums, galleries, and performing arts venues throughout the city. Over the past nine years, it has drawn more than a million and a half visitors, with millions more viewing the programs online.

It all had to start somewhere, and if you look back to 2005, one of the festival's cofounders and current chairman of the board of directors, Dr. Brian Greene, "had never even heard of the idea of a science festival," he tells SPS.

In 1999, Brian Greene rose to prominence as a science communicator after publishing *The Elegant Universe*, his book about string theory written for a general audience. In 2005, the Italian translator of his book told him about a science festival that had taken place in Genoa, Italy. As the translator described the events that had happened all throughout the ancient town of Genoa, he thought, "If a science festival was something that could succeed in Genoa, how thrilling would it be to make a New York version of this?" To him, "it was a great challenge" and one that he eagerly took on.

He saw his vision of a science festival in New York City realized for the first time in 2008 and since then

TOP: Brian Greene onstage in *Light Falls: Space, Time, and an Obsession of Einstein*.

MIDDLE: Kids of all ages searched the skies at *Saturday Night Lights: Stargazing in Brooklyn Bridge Park*.

RIGHT: Children get the unique opportunity to play astronaut for the day at *Street Science*. Photos courtesy of the World Science Festival.


NASA

STREET SCIENCE CONNECTS YOUTH TO THE EXCITEMENT of scientific discovery with hands-on demonstrations. Photo courtesy of the World Science Festival.

has been continuously surprised by the variety of people that enthusiastically come to its programs.

Its audiences have people from all walks of life. The festival, he says, is "recognition that science cuts across all of these boundaries and hits people at a deep place of curiosity and wonderment."

It is by tapping into that broad appeal that Greene entices the public to learn about science.

"The best way to get someone interested in these ideas is if it's organic, if you don't sell them on it, don't somehow force them," he says.

Brief interactions—a demo, a short paragraph in a book, or even just a visual on TV—can be enough to form a connection between the learner and science.

Greene credits that connection to what he refers to as a "human hook...a metaphor, analogy, story, or historical episode."

Once given the chance to share the science, it, too, must be presented in an accessible way. You need to "meet people at their level," Greene instructs. He achieved this in his book, *The Elegant Universe*, by "describing ideas with a variety of different metaphors, at varying levels of difficulty." Presenting the information at a variety of levels gives audience members "permission to not understand everything, which allows for a much broader appeal."

Greene attributes his success as a communicator to being, first and foremost, a scientist. But he adds that he also sees his role as that of a translator, "keeping one foot in the actual research and another foot in the general public community, helping each to understand the other."

Greene says he initially developed his skills as a "translator" by analyzing his own learning process. As a student, he "required mental imagery to bolster [his] mathematical understanding." Now, when talking to the public, he can "strip

AUDIENCE MEMBERS GET AN UP CLOSE and exciting demonstration at Street Science. Photos courtesy of the World Science Festival.

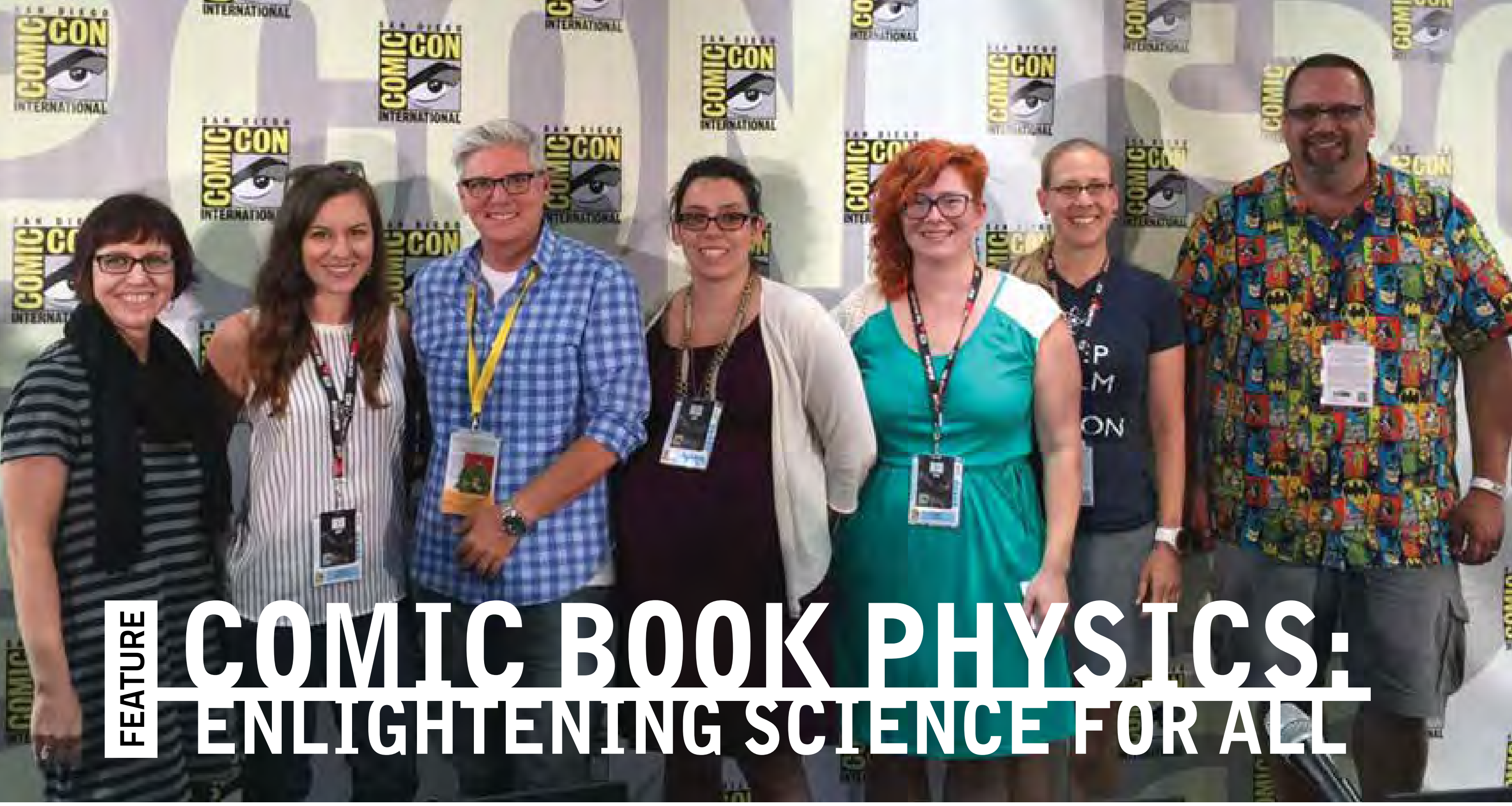
away the math and use that [same mental imagery] as a basis of communication."

His advice to undergraduate students of science is to "learn the basics of your field inside and out. Do not let anything at an early stage intrude on that foundational understanding that will serve you for a lifetime. At the same time, read popular books and articles that can help you have a larger vision of why the details of your work really matter to people. Have a feel for the big ideas and how it can inspire the public to want to further understand the intimate details of your research."

The nitty gritty of any topic can put people off. In communicating his own work about cosmology and string theory, he makes sure to use the big, interesting questions about the origins of the universe to keep his audience curious about the details.

Undergraduates should seek out opportunities to practice these communication skills. Greene suggests acting as an "explainer" at a public program by attending the program and then explaining the science behind it to members of the audience. If this is not an option, use your school's demonstrations department to host your own event.

Ultimately, you will need to find what works for you. It is only through practice and experience that you will find the talent you bring as a communicator, or that you will strike your own balance between research and outreach, between human hook and science communication. //



FEATURE

COMIC BOOK PHYSICS:
ENLIGHTENING SCIENCE FOR ALL

by Rachel Kaufman, Contributing Writer

Faster than a speeding bullet (by a long shot), able to pass through transparent surfaces in a single instant—it's Spectra, the original laser superhero!

Spectra is a middle school girl with the powers of a laser. Created and written by Becky Thompson of the American Physical Society (APS) as part of the PhysicsQuest educational program, Spectra and her friends now star in seven adventures and counting.

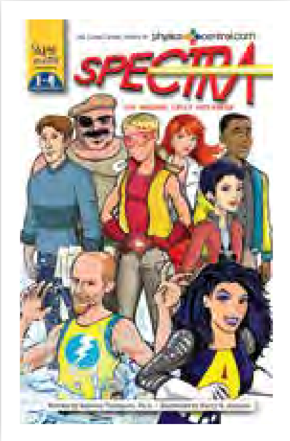
Educational comics have been around in some form for years, but recently they have been gaining more acceptance; it's into this tradition that the Spectra comics solidly fit. Spectra is a bit different, though, in that Thompson promotes the comics at teachers' conventions and at mainstream comic events, like San Diego Comic-Con. Thompson just returned from her seventh year at the convention.

Thompson originally created Spectra as part of Laserfest, a celebration of the 50th anniversary of the first working laser. PhysicsQuest had dabbled in comics before, doing a biographical comic about Nikola Tesla, for example, but Spectra was APS's first original character and first superhero.

The plot is pure old-school comics: "Lucy Hene [a mashup of the chemical symbols for helium and neon, of course] is a normal girl, and she develops, overnight, laser powers," says Thompson. "All of her superpowers are things that lasers actually do." So Lucy can pass through transparent surfaces, change colors depending on her energy level, even play CDs. In previous adventures she's crossed paths with the Quantum Mechanic, General Relativity, Tiffany Maxwell (and her demon, of course), and the evil Miss Alignment and her henchmen.

"The goal is to get [kids] interested and excited about physics," Thompson says. "They're not necessarily going to be able to walk away and ace a test on hydrodynamics, but they'll be able to use the words involved. They'll be more likely to try a bit of physics."

To that end, it's no coincidence that Spectra is a girl. "There's a huge underrepresentation of women and minorities in physics," Thompson says, as in comics. "One of the things I love seeing is the big sister who got dragged to this stupid thing with her brothers, and she sees this female superhero on the cover [of Spectra] and she's like, 'Oh, wait, someone did this for me?'"



While both boys and girls seem to enjoy the comic, Thompson says she worked hard to make sure Spectra felt "welcoming to girls," including spending a lot of time talking to the nonprofit Girl-Wonder.org, which is dedicated to positive representations of women in comics. "They said

GET INVOLVED

Becky Thompson and James Kakalios, author of *The Physics of Superheroes*, will lead a workshop titled "Communicating Science to the Public with Superheroes" at PhysCon 2016 (see "PhysCon Preview" beginning on p. 28). This workshop will describe how one can use superhero comic books and motion pictures to illustrate a broad range of physics concepts and principles, and make them accessible to general audiences.

girls are really smart, and they know when they're being marketed to. If you take a made-for-boys comic and put pink on it, they won't read it."

More importantly, of course, is this question: Are they actually learning? The answer appears to be yes. Kids are "just little sponges," as Thompson says. "The amount they suck up from reading is amazing....We had one dad who was a physicist, brought the comics home from a conference, threw them down, and three days later his kid is coherently explaining lasers to him. The goal is not to have that happen but to allow that to happen."

As APS publishes more and more Spectra adventures and kids learn more and more about physics, Thompson is also learning about the comic book world. She laughs when she recalls her first Comic-Con appearance seven years ago, something she was completely unprepared for. "I knew this would be a good way…to reach middle schoolers, but that was about it," she said.

"We had no idea how many comics to bring—there are 125,000 people attending a day. The biggest conference I usually go to has 6,000 people," she said. "So I printed a bunch. We have four pallets of comics, a team of six people, none of us know what we're doing, and [our booth faces] the DC Comics booth. They're installing the original Superman costumes, and here I am with a cardboard cutout."

The Spectra booth gets bigger every year, though Thompson remains a bit awed by the entire thing. "We know what to expect and how we fit into it, but the fact that we even do fit into all of it is amazing. This is like the real comic book world. The fact that we're not just there but we have people remember us—these are people that paid thousands of dollars to come here because they like comic books that much. It's awesome that they're taking the time to stop by and talk to us… It's surprising how many people are not scientists but do appreciate that there is real science in comics."

Spectra may have starred in seven comics so far, but it's truly only the beginning. Her next adventure comes out this fall, in which the Terminal Twins star as the villains, and kids learn about electricity and magnetism. And there's still Spectra's origin story, which as of now is known only to Thompson, and a wide range of other physics that can be taught with the help of lasers. Basically, Thompson and her plucky superheroine are just getting started. //

TOP LEFT: Becky Thompson, second from right, with fellow panelists at San Diego Comic-Con.
LEFT: A special reprint of the first four Spectra comic books.
ABOVE: Thompson, front row, middle, with APS staff at the San Diego Comic-Con Spectra booth.
Images courtesy of Becky Thompson.

FEATURE

OSA STUDENT CHAPTERS CELEBRATE THE OPTICAL SOCIETY'S CENTENNIAL

GLOBAL EVENTS RANGE FROM STUDENT OUTREACH TO NOBEL PRIZE WINNERS AND SYMPOSIA

by Chad Stark, Executive Director, OSA Foundation

The Optical Society (OSA) is celebrating its 100th anniversary, marking a century of innovation.

Throughout the year, The Optical Society Centennial has featured a robust celebration of our past and future. Events like the "Light the Future" speaker series, our special centennial exhibit, and contests such as "Write the Future" celebrate our legacy as well as examine where optics and photonics will lead us.

An important aspect in looking at the future of optics is the next generation of innovators who are part of OSA student chapters.

Since the first chapter was founded at the University of Rochester in 1982, over 350 student chapters worldwide provide an important professional resource for future scientists. These chapters, which are managed for and by students, create valuable opportunities for professional development and foster lasting relationships between peers and mentors. In addition to their benefits for members, many chapters are heavily involved with community and youth education outreach to both provide a service to their community and work to disseminate the knowledge of optics and photonics worldwide.

OSA student chapters have taken an active role in celebrating our centennial through various programs, traveling lecturers, and events. In 2016 we will award 150 grants through our OSA Traveling Lecturer Program, which provides funding for student chapters to host a technical or professional development guest speaker of their choosing annually.

Student chapters have also been able to take advantage of special centennial-year programs, like the Centennial Special Event Grant Program. This program provides OSA student chapters with the resources to engage their local community through youth education programming as well as professional development for their members. It encourages our members to plan large-scale and impactful programs that promote the science of light.

Some of the events and programs funded by the Centennial Special Event Grant have included:

Founded in October 2015, the **OSA student chapter at the Xi'an Institute of Optics & Precision Mechanics** has grown from six members at its founding to 40 today. The group hosted several activities to commemorate The Optical Society Centennial. As part of the celebration, professors at the University of Auckland, University of Science and Technology of China, National Tsing Hua University, and students from nearly 30 universities and institutes were invited to participate in the National Doctoral Academic Forum on Optics and Photonics, as well as other key activities, including lab tours, group photos, awards for best presentations, and a special centennial celebration of OSA. The invited speakers helped paint a picture of how far the fields of optics and photonics have progressed since OSA's founding in 1916 and what the future may hold. The celebration even included a special birthday cake for the centennial.

The **OSA student chapter at Zhejiang University in China** used Centennial Special Event Grant funds to expose primary school and high school students to optics, science, and discovery. Over the course of four months, the student chapter visited over 800 students and participated in youth education activities. These outreach events helped expand students' horizons when it comes to science, and the student chapter volunteers were amazed and pleasantly surprised at how quickly students were able to grasp certain concepts and answer questions that were seemingly beyond their reach.

The **Queensland University of Technology (QUT) OSA student chapter** in Australia marked OSA's centennial by organizing their first ever OSA lecture series. In collaboration with the QUT school of Optometry and Vision Science, the QUT student chapter welcomed Professor Ian Cowling and Dr. Atanu Ghosh as their featured speakers in an event designed to educate and spread the awareness of a wide field of application of optics and light-based technologies in science, engineering, and other health research. The event drew over 40 attendees, and thanks to this success, the student chapter is planning to host at least two lecture series per year moving forward.

The **OSA student chapter at Vilnius University** in Lithuania celebrated the centennial under the "stars" by hosting an "OSA Welcome Evening" at the Planetarium of Vilnius University. The students were excited to begin the evening with a special live broadcast of a lecture given by Dr. John Mather, senior astrophysicist at NASA's Goddard Space Flight Center and 2006 Nobel laureate. The evening's festivities continued with students and attendees sharing their thoughts on Dr. Mather's speech and enjoying the evening under the projection of stars and planets at the only specialized information center of astronomy and natural sciences in Lithuania.

The **OSA student chapter at the College of Optics and Photonics (CREOL) at the University of Central Florida** celebrated OSA's centennial with an evening event at their campus in Orlando this past April. Eric Van Stryland, past dean of CREOL and past president of OSA, gave a presentation highlighting OSA's centennial activities around the world. Gregory Quarles, chief scientist at OSA, discussed growth trends in the optics and photonics industry and offered career guidance to the students and faculty in attendance. Following the presentations, attendees enjoyed a reception which featured OSA's centennial exhibit and a special OSA 100 cake.

The Optical Society Centennial is the intersection of our defining history and our limitless future. Throughout this year and beyond, we reflect on a century of illumination and look forward to another 100 years of breakthroughs. We are OSA proud, and we know that the future is in good hands with these young inventors, engineers, and scientists currently in OSA student chapters. //

LEFT: Attendees await the live broadcast of Nobel winner Prof. John C. Mather's presentation at the "OSA Welcome Evening." The event was hosted by the OSA student chapter of Vilnius University at the university's planetarium.

TOP: A member of the OSA student chapter at Zhejiang University works with children from Youth Homes in Hangzhou on activities from the Optics Suitcase.

BOTTOM: Students from the University of Maryland's OSA student chapter celebrated the centennial in a sweet way with this cake displaying OSA's centennial logo.

Photos courtesy of The Optical Society.

To learn more, contact mediarelations@osa.org or visit osa.org/100.

PHYSCON PREVIEW

Congress is COMING

ARE YOU READY?

This November, hundreds of physics students, faculty, and practicing physicists will converge in the San Francisco Bay area for a meeting unlike any other: the 2016 Quadrennial Physics Congress (PhysCon)!

Peruse the pages that follow to explore the lives of the PhysCon plenary speakers, including one who speculates that we might, in fact, be living in a giant computer simulation, and another whose childhood fascination with black holes ultimately landed him at LIGO, an observatory that recently confirmed the existence of gravitational waves.

The countdown is on, so mark your calendar for November 3–5! Now is the time to make up a budget, apply for money from your student government, plan your fundraisers, and ask your department what else you can do so that you can pack your bags for an incredible experience. //

JOIN US AT PHYSCON!

Register by Oct. 14 at www.sigmapisigma.org/congress/2016/registration.

ABOVE: Scenes from the workshops, tours, and exhibit hall at PhysCon 2012. Photos courtesy of the American Institute of Physics.

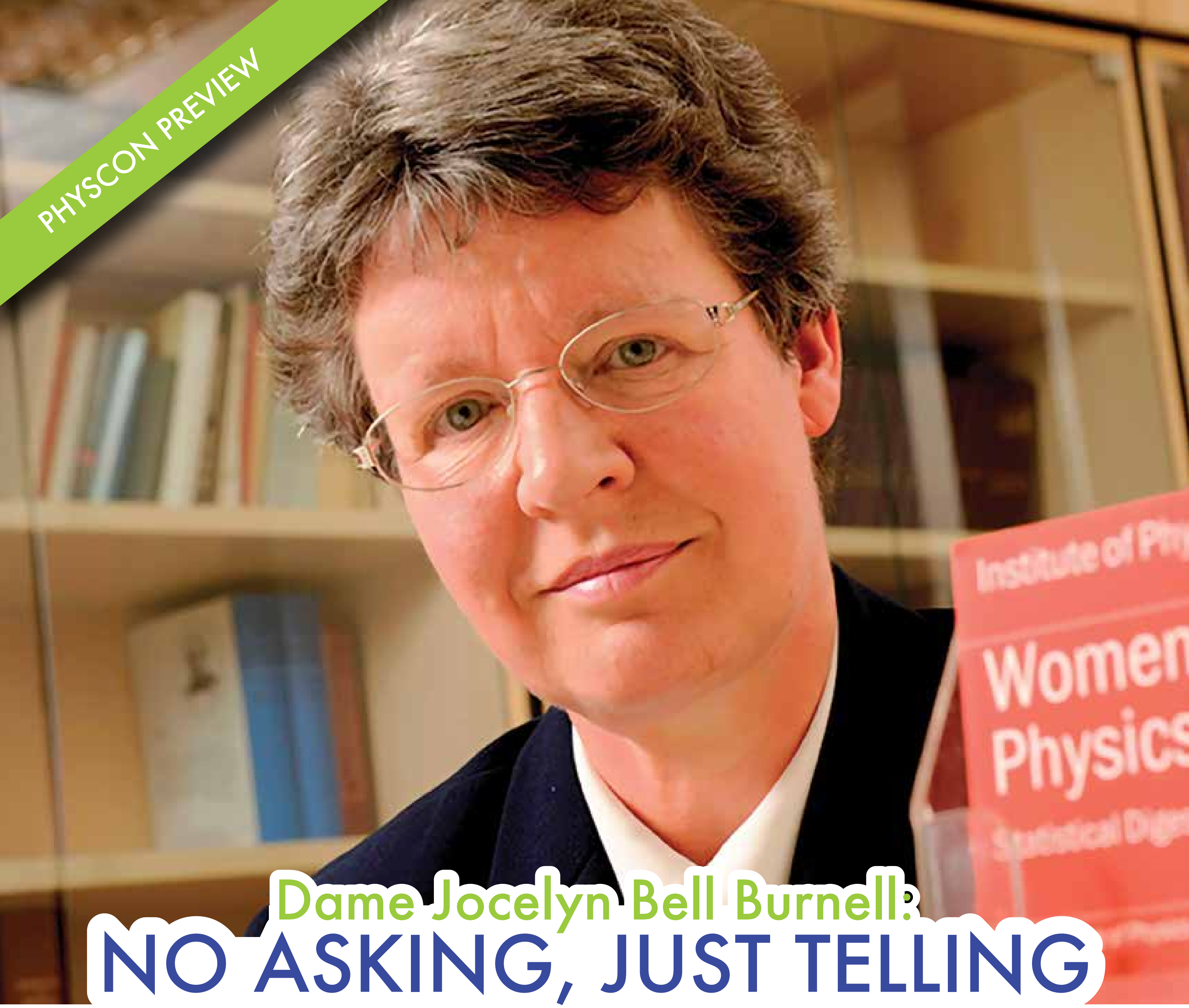
DIG DEEPER

Visit the PhysCon website for details on the workshops, poster sessions, art contest, tour sites, dance party, and logistical details: www.sigmapisigma.org/congress/2016.

Download the PhysCon2016 App now in the App Store or Google Play Store.

physcon
2016 Quadrennial Physics Congress

PHYSCON PREVIEW



Dame Jocelyn Bell Burnell: NO ASKING, JUST TELLING

by Rachel Kaufman, Contributing Writer

Renowned astrophysicist Jocelyn Bell Burnell is the honorary chair of PhysCon.

Recalling a grade-school incident during a 2013 TEDx talk, Jocelyn Bell Burnell says that one day, an announcement was sent out that girls were to go to one room, boys to another. “And I thought it was sport,” she said.

“It wasn’t. The girls got sent to the domestic science room and the boys to the science lab. No asking, just telling. That’s where you went.”

Her parents, and a few others, were outraged, and Bell Burnell was moved to the science class with two other girls. "The teacher made us three girls sit right under his nose. I came in top in the science exam at the end of that term."

That young woman would go on to discover the first pulsars. The British press, upon discovering that the scientific sensation of the day was an attractive graduate student, descended on Cambridge. "They had their preconceptions," Bell Burnell told SPS. Instead of asking about her work, they asked for her waist size.

Now, almost half a century later, Bell Burnell is a world away from the woman who would "forget" her measurements when talking to the press.

She has dedicated her life to research, teaching, and ensuring that the sciences are a welcoming place for all. “Women should not have to do all of the adapting,” she wrote in a 2004 editorial for *Science*. In her 2013 TEDx talk, she elaborated: “Those of us who've been early in a field have often had to… play the male game. And I hate to think what a lifetime of doing that has actually done to me.”

Dr. Bell Burnell was born Susan Jocelyn Bell in 1943 in

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

physcon
2016 Quadrennial Physics Congress

Northern Ireland. She excelled at science, and after finishing her physics degree at the University of Glasgow, she went to Cambridge to complete her Ph.D.

During her first two years there, Bell helped build the telescope she would use for her thesis. Under the supervision of Antony Hewish, she and a half-dozen others strung miles of cables over four and a half acres.

"Once the equipment was built, I ran it solo," she said. The machine was built long before ubiquitous computing, so it produced paper charts—96 feet each day. She would roll the charts out on the floor and analyze the patterns, inch by inch, for signs of scintillating ("twinkling") quasars.

A few weeks into the telescope's operation, she discovered a quarter-inch of what she called "scruff" on the chart. It resembled a star, but no star could produce a signal quite like this one—or so it was thought.

After "enlarging" the signal, Bell saw a series of regularly spaced pulses. Hewish was convinced the signal was interference. "It was nonsense," he said in the BBC documentary *Beautiful Minds*. But once Bell and Hewish confirmed the pulse in another telescope, they knew they were on to something big.

Bell Burnell soon found a second, third, and fourth similar signal elsewhere in the sky. Each was a pulsar, for “pulsating star,” a rapidly rotating neutron star that emits a beam of radiation—much like a lighthouse’s rotating lamp.

Finding a second pulsar "was a huge relief," Dr. Bell Burnell told SPS. "The first one was actually quite worrying, because it was such an outrageous signal that you really were very puzzled as to what was going on. Finding the second one then begins to make clear that it's more natural and normal than you have been fearing."

Bell and Hewish published their findings in *Nature*. Hewish—not his graduate student—would be awarded the 1974 Nobel Prize in Physics, alongside Martin Ryle, "for his decisive role in the discovery of pulsars."

Dr. Bell Burnell would by then be married and spent much of her career following her husband from place to place.

It was only after her marriage had broken up and her son had gone to college that she "was able to go off to jobs because of what they were rather than where they were."

She chose to teach at Open University, a school for nontraditional students. Her appointment to the chair of physics position, she said in her 2013 TEDx talk, doubled the number of female professors of physics in the country.

Now retired from active teaching and research, Bell Burnell was elected in 2014 president of the Royal Society of Edinburgh, Scotland’s national academy of arts and letters—the first woman to hold such an honor. It “is a great privilege, but also hard work,” Bell Burnell told SPS.

“The position of women in science, technology, etc., in the UK has improved markedly in my lifetime,” she said. “Indeed, the whole of society in the UK is much more female conscious, in the sense it is no longer male dominated, and if someone produces a list of prize winners and there's no women amongst them, people comment!”

But, she said in 2013, “I think the culture of science needs to change as well.”

“Science, technology, engineering, maths are incredibly important to help build a smart economy. We need all the talent there is. We need all the bright ideas there are as well, and we cannot afford to be turning aside from a fair chunk of the population.” //

PHYSCON PREVIEW

For Patrick Brady, LIGO's Success is JUST THE BEGINNING

by Rachel Kaufman, Contributing Writer

When scientists working with the Laser Interferometer Gravitational-Wave Observatory (LIGO) announced in February that the observatory had detected gravitational waves for the first time, physicists around the world were thrilled,[1] perhaps none more so than Patrick Brady, who has spent the last twenty years of his life working on LIGO, now as an executive committee member of the LIGO Scientific Collaboration.

For Brady, who has been fascinated by black holes since childhood, LIGO's success was a triumph.

"We knew there was something in the data very soon afterwards. I woke up in the morning after the event—it was about three hours after the wave had passed the earth," Brady says. "I was grinning from ear to ear, and wondering to myself, 'Why am I grinning from ear to ear?' And then I was like, 'Yeah, this is a pair of black holes that collided a billion years ago in the universe.'"

Brady was born in Dublin and took to math and physics early on. "Black holes were a big hit," he says.

After getting his bachelor's and master's at the University College Dublin, he moved to Canada to study under cosmologist Werner Israel.

"We worked on some very esoteric concepts about black holes, [things] that will never be observed," Brady says. It sounds like sci-fi, but essentially they were trying to determine whether black holes really were wormholes to other universes. "This is a fascinating idea," Brady says, "but ultimately one that, at least for now, can only be theorized about."

"Someday we'll go back to studying it again—for now I'm focused on something that can be [measured.]"

Following the completion of his Ph.D., Brady went to the California Institute of Technology as a postdoc in 1995. After years of uncertainty, LIGO had finally been funded but not yet built.

"To some extent I didn't realize how early on it was." But he agreed to stay and work on the project. Brady's role was to help learn how to use LIGO as a new tool.

"The interesting thing about LIGO as an astronomical

LEFT: A simulation of gravitational waves generated by a binary black hole system. Image credit: iStock.com/gmutlu.

RIGHT: Patrick Brady. Image courtesy of Patrick Brady.

observatory is that it's a brand new tool. Nothing like it has ever been used to look at the universe before." It's not as simple as flipping a switch and getting results. People needed to "learn how to analyze the data, how to interpret the data...how to build the software that would take the data and use it to figure out if there was a gravitational wave present."

LIGO, the Laser Interferometer Gravitational-Wave Observatory, is an instrument originally proposed in the 1960s to detect gravitational waves by looking for slight variations in two laser beams that travel back and forth along 4 kilometer long arms, eventually recombining near their origin points. Any gravitational waves would change the length of the arms slightly, which would change the relationship to the two laser beams and create an interference pattern.

When Einstein first proposed the existence of gravitational waves in 1916, measuring them seemed like an impossible idea. "He said we'd never be able to do it," Brady says.

LIGO was finally turned on in the early 2000s, which was a long, arduous process.

"It wasn't just one day," Brady says. "The instruments are very complicated. But even in that initial LIGO phase when we went into our first science run, the first time that we felt the instruments were good enough to try to search for gravitational waves in a serious way, it was very exciting. I do remember how excited we were. We didn't see any gravitational waves, but still, we were pretty thrilled."

Yet it would be another decade and a half, and a series of improvements designed to enhance LIGO's sensitivity, before the observatory made the announcement that the instrument had detected gravitational waves from two black holes colliding.

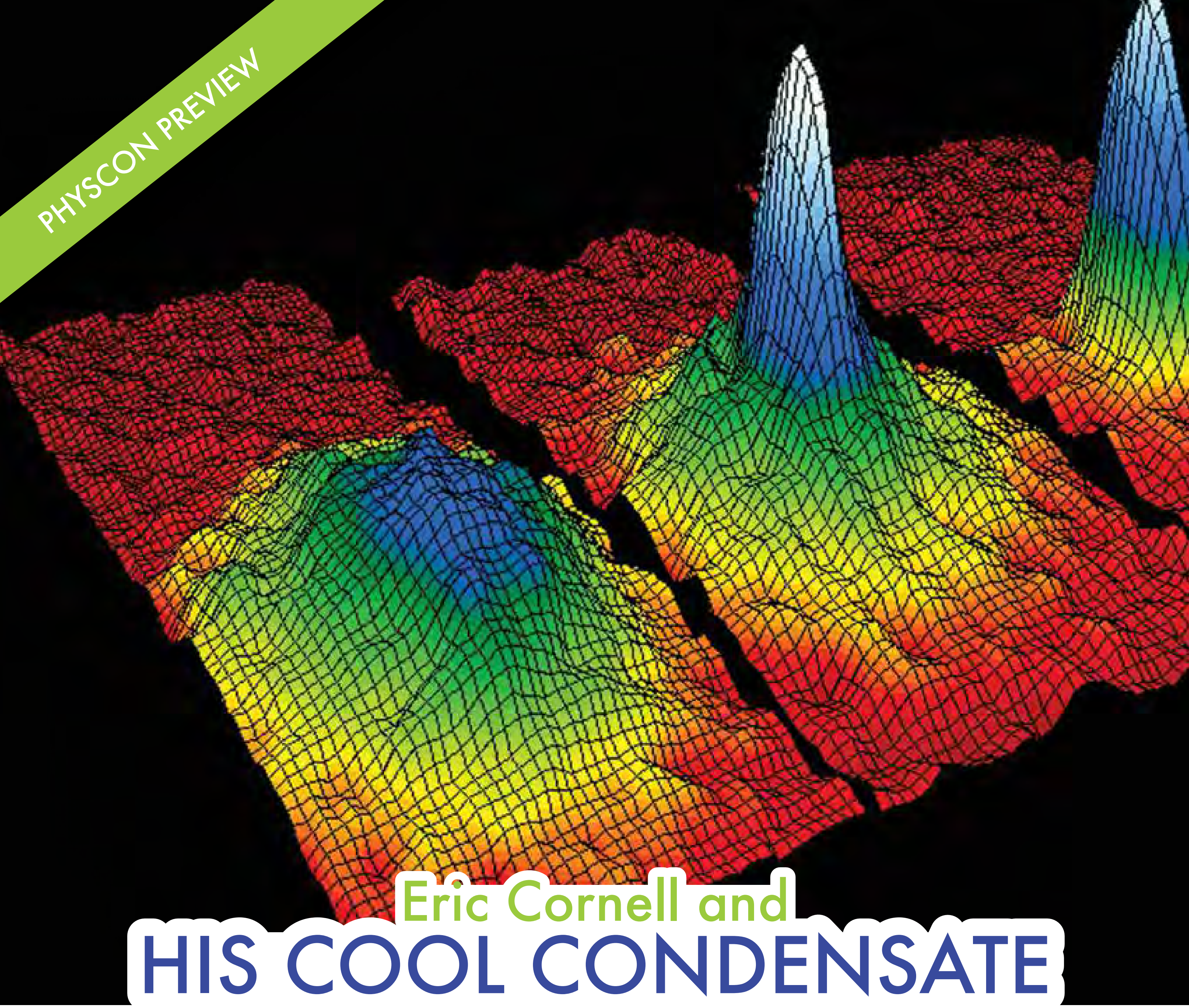
The headlines all said that the detection vindicated Einstein's theories, which is true. But to Brady, the first detection is only "the first checkmark." He says that the point wasn't to prove Einstein correct but to see what physicists can now learn about the universe.

LIGO "is a tremendous new way to start to learn about what's going on in the universe… It really does open up to us a new sense, just like vision or sound.

"The truth of the matter is, we get to first of all answer the old question that was posed in 1916 by Einstein—are there gravitational waves? Absolutely, here you go. But now we get to ask a whole new set of questions about how the objects in the universe came to be, how they interact with each other, and how they change over time—new astronomy that we're going to get to do over the next several years and decades." //

1. B.P. Abbott et al. (LIGO Scientific Collaboration and Virgo Collaboration), Observation of gravitational waves from a binary black hole merger, *Phys. Rev. Lett.* 116, 061102 (2016).

PHYSCON PREVIEW



Eric Cornell and HIS COOL CONDENSATE

by Rachel Kaufman, Contributing Writer

What happens when things get cold? Not just scarf-and-mittens chilly or even midnight-in-Antarctica cold—but really, really cold?

Answering that question earned Eric Allin Cornell a Nobel Prize.

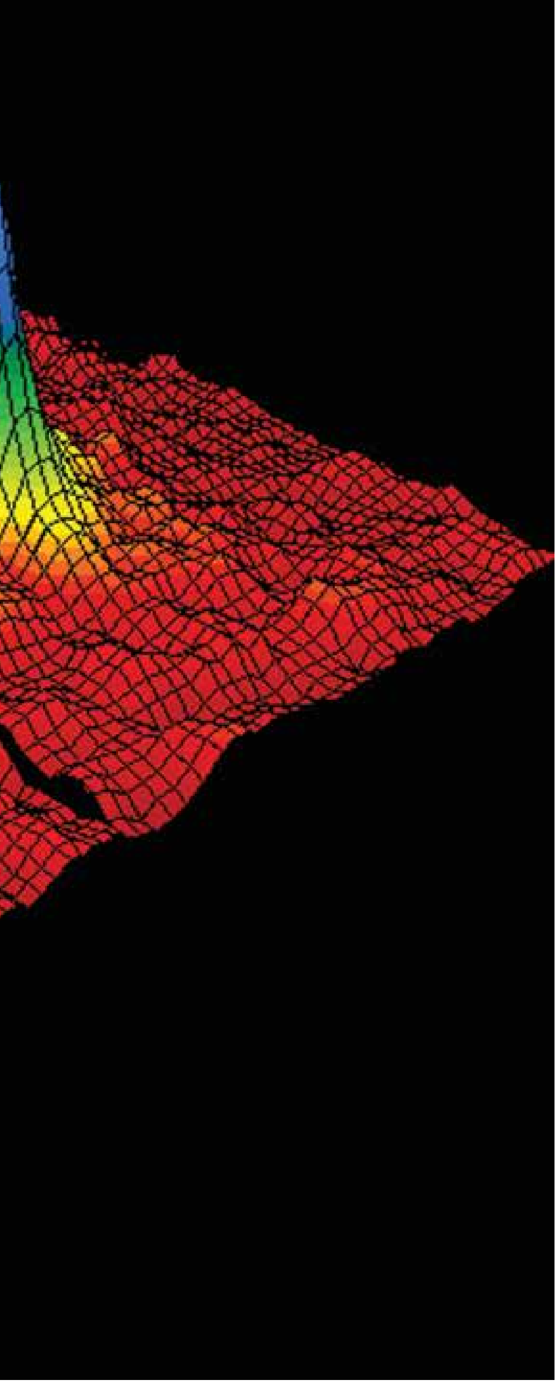
In 1995, he, along with Carl Wieman, synthesized the first Bose–Einstein condensate (BEC) using a process that cools matter to temperatures that seem impossibly low. Even the deep vacuum of space is far too warm for Bose–Einstein condensates. Only if you can get down to about 170 nK—about 0.00000017° above absolute zero—do some weird things start happening.

Born in Palo Alto in 1961, Cornell grew up in Cambridge, Massachusetts, where he was "an all-around curious kid," he told Sigma Pi Sigma, reading books surreptitiously during class and pondering physics brain teasers at night.

As an undergrad at Stanford University, Cornell majored in physics, "But I wasn't necessarily gelled there," he told Sigma Pi Sigma. "I thought I would pursue something more on the humanities or social sciences side."

Ultimately, it was a job during the summers and after school that tipped the scales, as well as a year in Asia.

Cornell had taken a year off from college to study Chinese and teach English in Taiwan. He returned from that experience realizing that physics was something he excelled at and enjoyed. He was spending afternoons and summers working with the low-temperature physics groups to earn money. "The [physics] classes were okay," Cornell says. "It was really the after-school and summer thing that I



LEFT: Velocity-distribution data (three views) for a gas of rubidium atoms, confirming the discovery of a new phase of matter, the Bose–Einstein condensate. Eric Cornell's work on this topic was recognized with a Nobel Prize in Physics. Image courtesy of NIST/JILA/CU-Boulder.

RIGHT: Eric Cornell. Image courtesy of Eric Cornell.

found so thrilling. That was, I would say, really the thing that made me think I wanted to go and do physics."

After graduate school at the Massachusetts Institute of Technology (MIT), he moved to a postdoc position at the Joint Institute for Lab Astrophysics (JILA), where his experience and interest in low-temperature physics led him to the discovery that won him his Nobel Prize.

"During those early years in Boulder, I spent a lot of time trying to imagine what a Bose–Einstein condensate would be like, if we could ever make one," he wrote in the biographical sketch he provided to the Nobel Committee. After his postdoc ended, he stayed at JILA to work on creating a condensate.

BEC is essentially a new form of matter, predicted by Satyendra Nath Bose and Albert Einstein in 1924 to occur when atoms are cooled to almost absolute zero. Physicists had been struggling to create BEC ever since to confirm Bose and Einstein's theory.

In 1992, when Cornell joined JILA as a professor, "The idea of BEC was in the air," Cornell wrote in the same biographical sketch. But the most advanced cooling techniques of the time were not powerful enough to reach the required temperatures.

"We were pretty optimistic in the face of a lot of skepticism," he told Sigma Pi Sigma. "We had some good arguments for why it would work."

Creating BEC at JILA required using laser and magnetic traps to bring a cluster of rubidium atoms close to absolute zero. Even 10 millionths of a degree above absolute zero is too warm to create BEC, so getting the substance cold enough took some doing.

Inspired by his advisor-then-supervisor Carl Wieman, Cornell tinkered with equipment using off-the-shelf parts ripped from fax machines and CD drives. "It was the fastest way," he said. "If you could put something together really fast like that, why bother to order some exotic thing that might or might not work?"

Speed was an important consideration. By the mid-1990s, skepticism in the scientific community had given way to excitement. Cornell says he

was less worried about not succeeding and more worried "that people were going to beat us to the punch."

But in 1995, Cornell, Wieman, and the JILA team first created and observed BEC. Doing so not only confirmed a 71-year-old theory, but also opened up a new branch of physics.

"As things get colder, their quantum-mechanical nature tends to get more pronounced," Cornell said. "They get wavier and wavier and less like particles. The waves of one atom overlap with another atom and form a giant superwave, like a giant, Reaganesque pompadour."

Hair metaphors aside, BEC is a way for physicists to observe quantum phenomena on, as Wieman has said, "an almost human scale." The BEC behaves like one giant atom.

For this discovery, Cornell and Wieman shared the 2001 Nobel Prize, along with Wolfgang Ketterle, whose team at MIT created BEC a few months after the JILA team. //

PHYSCON PREVIEW

Persis Drell Keeps Asking THE BIG QUESTIONS

by Rachel Kaufman, Contributing Writer

Like any good scientist, Dr. Persis Drell likes to ask questions.

The director of Stanford University's School of Engineering and former director of the SLAC National Accelerator Laboratory started her tenure as SLAC's director by asking a series of intentionally provocative questions, like whether the United States even needed SLAC at all. (Spoiler alert: She believes it does, but felt it was important to ask the question.)

Such is par for the course for Persis Drell, one of a handful of leaders in the international particle physics community. A new physics instrument is an opportunity to ask more questions. And running an engineering school, even one as well regarded as Stanford's, is an opportunity to ask, "what should we be doing differently?"

Born to noted physicist Sidney Drell, Persis grew up on the Stanford campus, in one of the original 12 homes that Leland Stanford built for faculty. It's now the school's Sexual Harassment Policy Office, Drell said last year.

Physicists would drop by the Drell household and stay late into the night—physicists like Hans Bethe, Richard Feynman, and T.D. Lee. Drell said in a 2015 interview, "I wasn't interested in the physics, but the people were fascinating."

"I would sit in the corner and just hope that no one would see me and send me to bed," she said in a 2008 interview. "And I would just listen. And watch."

In that environment, she grew up surrounded by physics but wasn't interested in the field at first. In fact, she said, she "tracked low" in math in seventh grade and had a "horrendous" high school physics class. But Wellesley College professor Phyllis Fleming inspired her to pursue physics. "I took every course Miss Fleming taught," she said. And then she took graduate-level physics courses at

PERSIS DRELL addresses the crowd at the SLAC 50th Anniversary celebration, Saturday, August 25th, 2012. Image courtesy of SLAC National Accelerator Laboratory.

Massachusetts Institute of Technology (MIT) while still an undergraduate student. She was hooked.

After more than a decade of teaching at Cornell University, she was pulled back west to teach at Stanford University and serve as an associate director for SLAC, the national accelerator laboratory run by Stanford. Five years later, she was running the place.

It was not an entirely easy transition. According to *Symmetry* magazine, about 18 months after agreeing to serve as SLAC's deputy director, she was ready to return to pure research. But then the center was hit by waves of layoffs and budget cuts, and Drell felt that "a new person coming in would have had a very difficult time doing what we had to do."

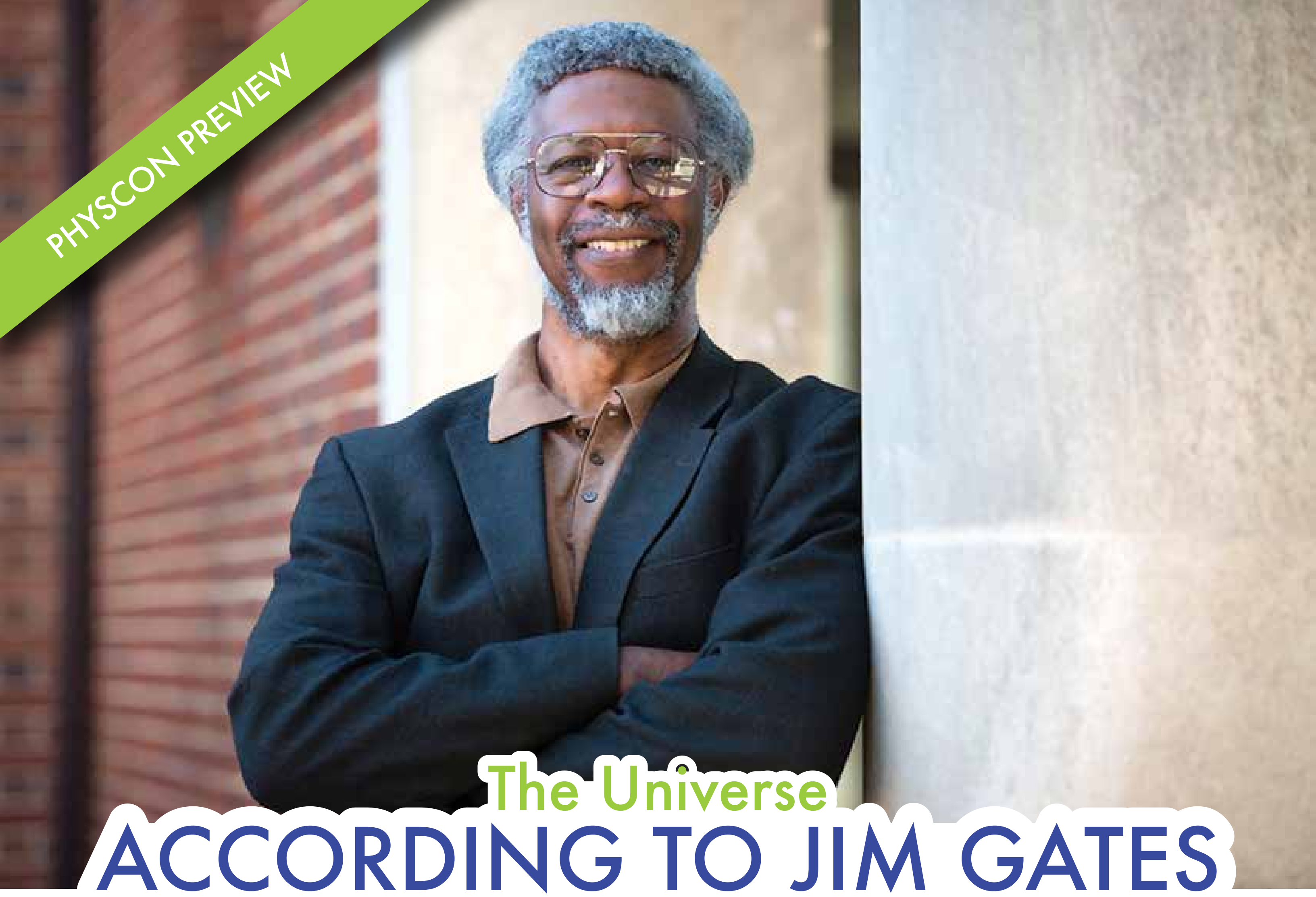
She ended up being instrumental in helping SLAC transition from a solely high-energy-physics–focused enterprise to a leader in multiple scientific disciplines. The Linac Coherent Light Source (LCLS), the world's first X-ray free-electron laser, came online during her tenure, and scientists are now using it to do everything from studying crystal formation to watching shockwaves in diamonds to developing better blood pressure drugs.

"We have a tool whose capability we really haven't fathomed yet," she said in a 2008 interview. "I really believe the Nobel Prizes on [the LCLS] are going to be won for experiments we haven't thought of yet, because the tool itself is so transformational."

Through it all Drell has also served as a mentor, especially for other women rising up in the ranks of a very male-dominated field. "She didn't really hide the fact that her family life was important to her," Ritchie Patterson, a Cornell professor who was Drell's first postdoctoral researcher, told *Symmetry*. "So she would move the seminar half an hour earlier so she could pick her kids up from daycare. There were plenty of fathers who needed to go pick up their kids, too, but who hadn't done anything about it or who snuck out early. I think it was probably a welcome change for an enormous number of people."

In 2014, Drell accepted the position of dean of the Stanford School of Engineering, where she almost immediately began an effort to define the next 20 years of the school. "We must avoid becoming complacent and continue to move forward. I don't know what the school will be like in 15 years; I just know it will be different," she said last year. So far those questions remain unanswered, but Drell will certainly keep asking them until she finds her answers. //

PHYSCON PREVIEW



The Universe ACCORDING TO JIM GATES

by Rachel Kaufman, Contributing Writer

If we are living in the Matrix, Jim Gates will probably be the first one to figure it out.

The theoretical physicist has spent his entire career looking for supersymmetry. It's a tough concept for many to wrap their heads around, but it proposes that all particles have partners, including some that we haven't discovered yet.

Along the way, Dr. Gates has gotten attention for discovering what he says is computer code in the math of supersymmetry. Specifically, he said he has found an error-correcting mechanism; others have analogized this code to the checksums that make the Internet work by ensuring that transmitted information is accurate. This find has led him to speculate—in a mostly joking way—that we might be living in a giant computer simulation.

What this would mean for our universe is not yet clear. But Gates is content to keep looking until he finds out.

Sylvester James Gates, born December 15, 1950, in Tampa, Florida, was fascinated by science at an early age. He cites books on space travel that his father bought him at age eight as sparking his interest. "A world exploded in my head," he said in 2013, "because I could see from these books that these tiny points of light in the sky at night were places you could go. And somehow in my young mind I knew that mathematics and science had something to do with going to those places."[1]

A bit character in an episode of the sitcom "Make Room for Daddy" inspired him to set his sights on the Massachusetts Institute of Technology (MIT). Gates told NOVA that seeing a smart kid who attended MIT on that show was "how I found out that there's a place you can go to college where they only make you study the good stuff," the good stuff being math, science, and engineering.[2]

But as he grew older, Gates, who is African American, faced racial biases on the road to college. "I had to

S. JAMES GATES is a University of Maryland physics professor who was awarded a National Science Foundation medal for his work in string theory. He is pictured outside the physics building at The University of Maryland in College Park. Photo by Sarah L. Voisin / The Washington Post via Getty Images.

learn to be black," he said in a 2013 speech.

A few years prior to Gates discovering MIT, his father left the US Army and moved to Orlando, Florida. At that time, the army had integrated schools, but Orlando did not.

"Segregation is an interesting phenomenon to experience," he said. "The people that are the minority come to believe the things that are said about them…One day on the playground…another African American said, 'You're pretty good at school.' And I said, 'Thank you.' And he said, 'But you can't be as smart as a white guy.'"

When it came time to apply to college a few years later, "I understood lots of things about the rules of how our society worked in those days, and I thought there's no way in the world that I would have the opportunity to go to such a place." He would have stopped himself from applying, but his father "literally forced me to fill out the application form."[3]

Gates was accepted. At MIT he earned two degrees, one bachelor's in math and another in physics, and went on to earn his Ph.D. there four years later. His dissertation was the first written about supersymmetry at MIT,[4] and no professors there could help him. Undaunted, he taught himself, earned his degree, and moved on to Harvard.

After a number of prestigious research and teaching positions, Gates landed at the University of Maryland in 1984. Since then, Gates has been plugging away at supersymmetry and string theory. His research has been recognized with the National Medal of Science and the Mendel Medal, as well as an appointment to the President's Council of Advisors on Science and Technology.

We do not yet know whether string theory or supersymmetry is true. The first round of experiments at CERN's Large Hadron Collider found no evidence of supersymmetry. But that's just a push to keep going, Gates says.

"String theory is often criticized as having had no experimental input or output, so the analogy to a religion has been noted by a number of people," Gates told NOVA. "In a sense that's right; it is kind of a church to which I belong. We have our own popes and House of Cardinals. But ultimately, science is also an act of faith—faith that we will be capable of understanding the way the universe is put together."[5]

And if string theory is correct, so what? Well, Gates admits he doesn't know. But think of scientists like James Maxwell who unified electricity and magnetism. "One can imagine saying, 'Professor Maxwell, what do your equations mean?' He would struggle for answers. He would say, 'Well, you know, the electric and magnetic phenomena are not separate, they're part of a unity.' But beyond that I think he would be rather hard-pressed to tell you what it means. One hundred and fifty years later we can answer this question very easily. A large fraction of our technological basis rests on his work."[6]

"So if string theory is correct, what does it mean? Well, one can imagine 150 or 200 years from now some marvelous piece of technology that's beyond my imagining. Maybe it's a transporter from Star Trek, perhaps it's warp drive, maybe our species finally is released from … being contained in a single solar system."[7]

Until then, Gates will keep looking. //

1. World Science Festival. "The Moth: Go Tell It on the Mountain – Jim Gates." YouTube video, 21:17. December 5, 2013, https://youtu.be/gDCbBWfhJ1o.
2. Gates, Jim. Interview with Joe McMaster. NOVA, Public Broadcasting Service, July 2003.
3. World Science Festival, 2013.
4. Ibid.
5. McMaster, NOVA, 2003.
6. Ibid.
7. Ibid.

PHYSCON PREVIEW

Rebel, Rebel: Neil Turok Builds a Career on INVESTIGATING THE "UNPOPULAR"

by Rachel Kaufman, Contributing Writer

As a student in primary school in Tanzania, Turok says he had teachers who encouraged learning by doing, "going outside as much as possible, making electric motors, taking apart cars." So when he moved to London at age 10, "I was horrified to find that people were doing a hundred sums—which were boring—as a mechanical exercise to learn how to do them."

Since then, Turok's been more or less poking holes in the dominant theories of the universe, as well as doing other things that he's been told can't be done. He worked with Stephen Hawking on the inflationary theory of the universe (and later rejected it); he now rejects most of the dominant theories of how the universe came to be. And despite being told he was crazy for doing so, he founded an advanced mathematical institute in Cape Town that has since expanded to six locations across Africa to give young Africans a master's-level math education. For this effort, which he believes will help ensure that the next Einstein will be African, AIP awarded Turok the 2016 John Torrence Tate Award for International Leadership in Physics, which will be presented to him at PhysCon this year.

Born in South Africa to anti-apartheid activists, Turok's young childhood was spent in Tanzania after his parents, both of whom had done jail time in South Africa, fled the country. "Insects always fascinated me, flowers, wildlife of all kinds," he tells SPS. "Living in Africa was pretty amazing in that respect—we had a lot of interesting bugs." In London he joined the British Entomological and Natural History Society, becoming the first child committee member of a club made up mostly of "retired gentleman naturalists."

He found physics "a bit lifeless" until he got to Cambridge, where he took physics as an "easy option." But during the course of that year Turok was exposed to cosmology, which he found "mindblowing." "You have very simple and precise laws but they describe the biggest thing we know—the universe—really well. The cosmos is very far from lifeless; it's the origin of everything. So instead of being concerned about where does life come from, I got interested in where everything came from."

After graduating and working at Princeton, he went back to Cambridge where he gave a talk about the primary

NEIL TUROK, winner of AIP's 2016 John Torrence Tate Award for International Leadership in Physics. Photo by Gabriela Secara.

2016 Quadrennial Physics Congress

cosmology model he was studying at the time. This got Stephen Hawking's attention. "We started working together developing his proposal for the beginning of the universe." As it happens, that rebellious streak struck again: "In my view that work largely showed that his proposal didn't work," Turok chuckles.

With Princeton cosmologist Paul Steinhardt, he developed an alternative, cyclic model for cosmology in which instead of a "big bang" there was a "big bounce" when a previous universe collapsed. But now Turok says, "I went off in this direction not because I particularly believed it to be true, but because I thought it was an important intellectual exercise which might teach us something about what is possible and what is impossible, and by doing that, broaden our minds to show us how much we don't know. If you find two rival theories can explain the same phenomenon in completely different ways, you've still learned something, because you've learned that neither is compelling. We developed the cyclical model more or less in the slightly contrarian spirit."

Around the same time Turok and Steinhardt were publishing their "big bounce" papers, Turok was also working on a deeply personal project. He turned a rundown art deco hotel in Cape Town into the African Institute for Mathematical Sciences (AIMS), an institute where Africans from across the continent can pursue a higher education in math. The school has expanded to six campuses and recently graduated its 1,000th master's-level student.

Originally, people thought Turok was "nuts" when he proposed AIMS. "They said, 'Africa needs clean water and food and medicine. Why on earth would Africa need advanced research?' The people who didn't think it was nutty were the young Africans themselves."

"It's been probably the most rewarding thing I've ever done in my life," he adds. "Most of the AIMS students are the first in their family ever to receive any form of higher education. Each time they go further, it's significant for their communities and their country." One AIMS graduate played a large role in helping to contain the Ebola crisis in West Africa. "He played a big role in saving many lives, based on his mathematical modeling on what different interventions would result in." Other graduates have gone on to work in microfinance, lead NGOs, or work in universities around the globe.

Turok now spends his time fundraising and advocating for AIMS, as well as continuing to study the mysteries of the universe. His new interests are in finding an even simpler way to explain the universe.

"This couldn't be a more exciting time observationally," he says, "but these observations are all pointing to [the idea] that the universe is simpler than any of our current theories can explain. What I believe is these are clues toward a new principle in physics which will explain why the universe is the way it is. My thinking has certainly evolved over the last five years, away from the types of models which are still popular in the field. In my view, these are all too complicated and arbitrary and contrived. The universe is speaking to us and telling us we're missing a very important principle." As for what that principle is? Turok—along with no small number of AIMS graduates—will be pushing to find out. //

Snappy Physics

MY INTERNSHIP IN BYTE-SIZE PIECES

by Isabel Binamira, Georgetown University, Washington, DC

ISABEL BINAMIRA. Photo by Matt Payne.

Though I did not have to physically travel far from Georgetown University to my internship at the American Physical Society (APS), the path I took to the SPS summer internship program itself was a bit more of a process.

When it became time to look for summer internships last year, I, along with many of my classmates, applied mostly to research positions sent out by our department. While glancing through the list, I found the SPS summer internship program among the long list. After a little investigation, I ended up applying because of how unique it seemed, as the experience was much more broad based.

When I heard back from APS, I admittedly took a while to get back to them. I had to seriously consider what it would mean for me to give up a summer research experience to work at a national society. Many people I spoke to told me I had to get research jobs over my summers, and I was worried that by taking the SPS internship, the lack of summer research experience would hinder my future prospects. But I soon realized that working with the APS Outreach Division was much closer to what I wanted to do with my physics degree. I attend Georgetown University where I have been heavily involved with the student newspaper, *The Hoya*, as well as a student-run consulting firm on campus. Through the intern program, I was able to find the perfect confluence of my interests in communication and problem solving. Internships such as the ones offered by SPS are valuable for people like me, who are considering a wider variety of science careers.

I was given a lot of freedom when coming up with my summer project for APS. I knew I wanted to focus on students who were just starting to seriously explore their interests in science. Many students within this age range, between 16 and 20, use social media as their main source of information. To capitalize on the relative novelty of the app Snapchat, I decided it would be a worthy endeavor to work on social media outlets, specifically, on the APS Snapchat account.

PhysicsCentral, APS' outreach arm, already had an account but had not used it. My goal for the summer was to create meaningful and interesting content that students would appreciate. Originally, I had planned to create a daily story for APS that would be pushed to all of the app's users, but upon further consideration, as well as talking to people at Snapchat's headquarters, we decided to scale back the project. Instead, I managed the account and tried to grow its followers. I attempted to find ways to partner with Snapchat to get the APS presence out there. We used Comic-Con this year as the first full-scale test of the account, updating followers on what we were up to in real-time. The account was popular during the conference, and a few people even followed us as a result of our marketing efforts at Comic-Con. The partnership plan moving forward is to send Snapchat headquarters details about conferences occurring in their cities of interest, and see if we can get airtime on their local stories.

As the ways people access information become more varied and tailored to their generation, it is important that outreach efforts evolve along with current trends. I feel Snapchat is one such avenue, and I hope to inspire people to pursue their interests in science as a result of my unexpected, yet ideal summer experience. //

BE A 2017 SPS INTERN!

Applications due January 15

The SPS summer internship program places undergraduate physics students with various organizations around Washington, DC, in the areas of science policy, communication, outreach, and scientific research. All internships include paid housing, a competitive stipend, commuting allowance, and transportation to/from Washington, DC. Check out the details at www.spsnational.org/programs/internships/.

Meet the
2016 SPS Summer Interns

To read their blogs and learn more about their projects, visit www.spsnational.org/programs/internships/interns/2016.

DAHLIA BAKER
Coe College
NASA Goddard Space Center Intern—worked on technology for two pathfinder experiments to measure the polarization of the cosmic microwave background.

DEMITRI CALL
Sonoma State University
AIP Mather Policy Intern—worked on the House Minority Committee on Science, Space and Technology on Capitol Hill.

ISABEL BINAMIRA
Georgetown University
APS Public Outreach Intern—developed Snapchat resources for the public outreach team, which aims to communicate the importance and excitement of physics to the public.

JOSE CORONA
Bridgewater College
NIST Research Intern—worked at the National Institute of Standards and Technology to develop high performance and reliable electron devices for the electronics industry.

MARIA MCQUILLAN
University of Saint Thomas
NASA Goddard Space Center Intern— researched the basics of time series analysis and image processing by contributing to two research projects on coronal heating and the solar wind.

MARIAH HEINZERLING
University of Rochester
SPS SOCK & NIST Summer Institute Intern—explored ways to distribute the entire collection of SPS SOCKs to a wider audience, and aligning with the Next Generation Science Standards (NGSS).

MARISSA MURRAY
Georgetown University
AIP FYI Science Policy Communications Intern—researched and wrote unbiased summaries of science policy developments for the physics and astronomy communities.

SAMANTHA SPYTEK
Virginia Polytechnic Institute and State University
AIP History Intern—contributed to new lesson plans and other resources for the AIP Teachers Guides to the History of Women and African Americans in the Physical Sciences.

SIMON WRIGHT
Wesleyan University
AAPT/PTRA Teacher Professional Development Intern—designed and revised resources for AAPT's high school teacher professional development programs.

TABITHA COLTER
Furman University
AIP Mather Policy Intern—worked in congressional offices on Capitol Hill, directly engaging in science policy issues and efforts in the nation's capital.

VANESSA ESPINOZA
Texas Lutheran University
NIST Research Intern—worked with the National Institute for Standards and Technology to develop high performance and reliable electron devices for the electronics industry.

VICTORIA DITOMASSO
CUNY Macaulay Honors College
AIP History Intern—contributed to new lesson plans and other resources for the AIP Teachers Guides to the History of Women and African Americans in the Physical Sciences.

How the APS March Meeting Influenced Me

AFTER LEARNING TO ROCK A POSTER SESSION, ONE UNDERGRAD IS FEELING CONFIDENT ABOUT THE FUTURE

by Eli Adler, Ithaca College, Ithaca, NY

My name is Eli Adler, and I am a graduating senior at Ithaca College and the president of our SPS chapter. When students ask me for advice, I often encourage them to present at—or even just attend—the APS March Meeting. Choosing to present my research was essential to my growth in the scientific and professional community.

It is extremely tough to fit all the great science from a research project onto a limited-size poster or a ten-minute talk, but being able to effectively communicate science is an important skill. Scientists are doing incredible research all over the world, but research will go unnoticed if not properly communicated.

Public speaking can be uncomfortable for many people, including me. The only way to overcome this fear is to practice. Practice in front of your research advisor, friends, colleagues, or even a wall. Having a good presentation will help your confidence, and you might teach someone something they didn't know or you might inspire someone to do similar research.

When giving a talk, you have ten minutes to tell your story and then answer some questions from the audience. With a poster presentation, other meeting attendees will either read your poster and then ask questions, or they will ask you for a summary of your research to start the conversation. I really enjoyed giving my poster presentation. I felt that I was able to teach people about science, and I became very confident in my abilities to communicate science.

The APS March Meeting also has specific sessions for undergraduate students that span multiple days, through the Future of Physics Days done in conjunction with SPS. Attending these sessions is a good way to discover the areas of physics that interest you. And while it can be intimidating to walk into a high-level physics oral session, talks by graduate students, professors, and research scientists may spark curiosity in a topic you didn't know you had.

The APS March Meeting is a great way to develop your skills in the scientific and professional world, and I strongly encourage all students doing research to give a talk or a poster presentation! //

NEXT UP

The next APS March Meeting will be March 13-17, 2017, in New Orleans, LA. For more information watch www.aps.org/meetings/march/.

BELOW: Undergraduate students ask questions during a Q&A session at the 2016 APS March Meeting in Baltimore, MD.

BOTTOM: Ithaca College students at the APS undergraduate student reception Photos courtesy of Ithaca College.

Journey to the **First SPS Chapter of India**

by Arpan Sharma, Vel Tech University, Chennai, India

At the 2016 April Meeting of the American Physical Society (APS), I was honored to accept the first charter for an SPS chapter in India. Our chapter is at Vel Tech University, which is located in the city of Chennai.

Vel Tech University currently has three national SPS members conducting research in computational fluid dynamics, biophysics, and smooth particle hydrodynamics. Partnering with juniors studying astrophysics, we came up with an antigravity chamber, planetary models, and satellite prototypes that we use to motivate students to take physics classes and live a life full of scientific adventure.

I was at the APS April Meeting to present my research on the purging of hydrogen in the space shuttle with analysis on interaction through smooth particle hydrodynamics. My journey from Chennai to Salt Lake City took 28 hours and included a 5-hour delay in Jeddah, Saudi Arabia. The trip was long, but the experiences I gained at the meeting were remarkable. After coming from a place with high temperatures, the weather in Salt Lake City was especially great.

I attended many sessions at the meeting, among which my favorite was a session that included talks by Arthur B. McDonald and Takaaki Kajita, who shared the 2015 Nobel Prize in Physics for their work on neutrinos. This session helped me understand the setup for the neutrino detection and how it confirmed neutrino oscillation.

There were also many events for undergraduates, including discussions on career opportunities for physicists, the presentation of the Future of Physics Days awards, and a contest to write a caption for a t-shirt. I enjoyed meeting the other students in these very active sessions.

During my poster presentation, I was delighted to meet the administrative body of the APS Forum on International Physics, who provided me with the funding to travel to Salt Lake City. I also spoke to many scientists about my research and appreciated their feedback and comments. It made me feel good about my work and raised my confidence for continuing my research in graduate school.

Attending the APS April Meeting was a memorable experience that made me optimistic about the opportunities ahead. It was a fun trip and one of my favorite journeys ever. //

BECOME A REPORTER!

SPS offers travel support at a level of $200 for chapters or individual students reporting on a national physics meeting for SPS. Find out more at www.spsnational.org/awards/reporter.

NEXT UP

The next APS April Meeting will be January 28-31, 2017 (yes, you read that right), in Washington, DC. For more information watch www.aps.org/meetings/april/.

TOP RIGHT: Arpan Sharma poses with the charter for the Vel Tech University SPS chapter, which he received at the APS April Meeting. This is the maiden SPS chapter in India.

RIGHT: Arpan Sharma is pictured by his poster with Maria Spiropulu, chairman of the APS Forum of International Physics. Photos courtesy of Arpan Sharma.

Zone 14 Meeting:

Life—And Physics—In the Academy

Civilian undergrads get a taste of Air Force Academy life at USAFA's Zone 14 Meeting

by United States Air Force Academy

The United States Air Force Academy (USAFA) SPS chapter hosted the SPS Zone 14 Meeting March 4–5, 2016. We had 35 visiting students and faculty from Colorado School of Mines, Colorado Mesa University, University of Colorado Denver, Metropolitan State University of Denver, and University of Wyoming. The zone meeting provided opportunities not only to discuss physics education and research, but also to foster interactions between military and civilian undergraduates.

We kicked off the meeting on Friday evening with a keynote lecture by Professor Eric Cornell of the University of Colorado Boulder, 2001 Nobel laureate in physics. Professor Cornell gave a talk on "Particle Paleontology: Looking for Fossils from the Early Universe Inside the Electron," describing the experiments his group is doing to measure deviations from the perfect roundness of the electron. The talk was both interesting and entertaining, and Dr. Cornell also took time to have casual conversations with students and faculty.

TOP: Students from the United States Air Force Academy, Colorado School of Mines, Colorado Mesa University, University of Colorado Denver, Metropolitan State University of Denver, and University of Wyoming pose with Nobel laureate Eric Cornell.

ABOVE: Cadet First Class and SPS President Anita Dunsmore poses with Dr. Cornell after presenting him with an engraved marble plaque, cut from stones that once outlined the cadet marching areas. Photos courtesy of United States Air Force Academy.

We continued the meeting on Saturday morning with SPS chapter reports, where each chapter shared highlights from their past year of activities. An interesting event presented during the chapter reports was a project that the USAFA chapter performed in collaboration with Colorado College showcasing the relativity of time due to gravity. Taking advantage of Colorado's mountainous terrain, the students at the two schools measured the drift in time between a sea level clock (given by GPS standard time) and a cesium atomic clock placed at various altitudes, including the top of Pikes Peak at 14,110 feet!

Dr. Alina Gearba, the USAFA SPS faculty advisor, talked about the upcoming Quadrennial Physics Congress (PhysCon) in Silicon Valley, stirring up a lot of enthusiasm, so we made plans to send a Zone 14 team to the congress. Rosa Wallace of the University of Colorado Denver, Zone 14 associate zone councilor, also talked about her experience in the SPS National Council and best practices for maintaining a healthy SPS chapter.

The meeting continued with student poster presentations and concluded with tours of the Academy's five research centers. The zone meeting provided plenty of opportunities for the students to mingle and share their interests in informal ways. Overall, we believe that our zone meeting was a success and we are looking forward to more opportunities to get together with the other SPS chapters in our zone. //

Zone 17 Meeting:

Making Connections in the Pacific Northwest

by Frank McKay (2015–17 Chapter President, University of Washington; 2016–17 Associate Zone Councilor, Zone 17)

This year the Zone 17 Meeting was held at the University of Washington (UW) in Seattle. When asked if UW was interested in hosting this meeting, we recognized it was a very large responsibility, but our chapter felt up to the task. We saw hosting the event as an opportunity to develop our leadership and team-building skills while sharing a lot of great activities and developing a better sense of community with the other chapters in our zone.

GET IN THE ZONE

Learn more about upcoming zone meetings and how to host one of your own at www.spsnational.org/meetings/zone-meetings.

Planning the zone meeting required a great team effort from our chapter. We decided to focus on events that were fun, yet educational, and then to work in teams to develop activities.

One of our planning teams developed a very exciting physics demonstration show. After riding in on a cart propelled by a fire extinguisher, they showcased our Wimshurst machine, ping-pong cannon, and many other fascinating contraptions. We even got to play with some liquid nitrogen and demonstrate the Meissner effect.

Another of our teams was in charge of presentations. We had four presentations in total, two from UW faculty members and two from undergraduate attendees. One of the highlights was the presentation by an undergraduate member of our club, Kyle Roberts, who gave a very entertaining talk about his research at the HIT-SI fusion reactor here at the UW. Some of our other teams focused on lab tours, food, and social aspects of the meeting, such as a game of Physics Jeopardy.

The meeting was a great opportunity to learn more about each chapter's activities throughout the preceding year. This allowed us to build relationships that will help coordinate events in the future. For example, representatives from Central Washington University and the University of Oregon came with us on a tour of LIGO in May. This event was attended by five different chapters from Zone 17, with more than 50 attendees overall. //

To see more details about the zone meeting visit: www.spsnational.org/meetings/meeting-notes/zone-17-spring-meeting.

TOP: Eryn Cangi of University of Oregon presents her poster about astrophysical synchronization.

BOTTOM: Frank McKay of University of Washington presents his poster about growth of tungsten di-selinide crystals. Photos courtesy of Frank McKay.

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