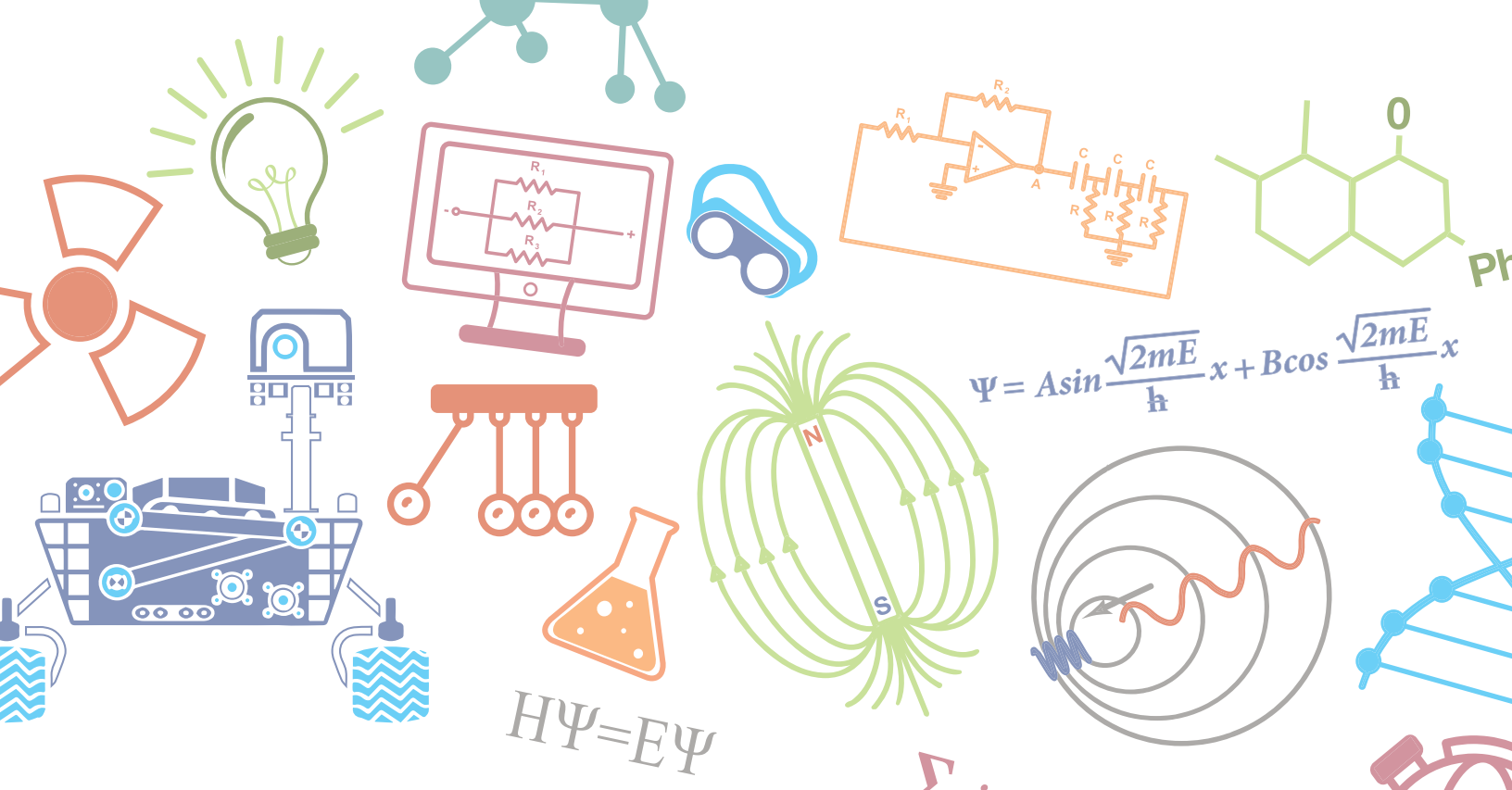


physcon

2016 Quadrennial Physics Congress

PROGRAM

Unifying Fields

Science Driving Innovation

November 3 - 5, 2016
Hosted by Sigma Pi Sigma, the physics honor society

AIP
American Institute of Physics

Contents

Online Content

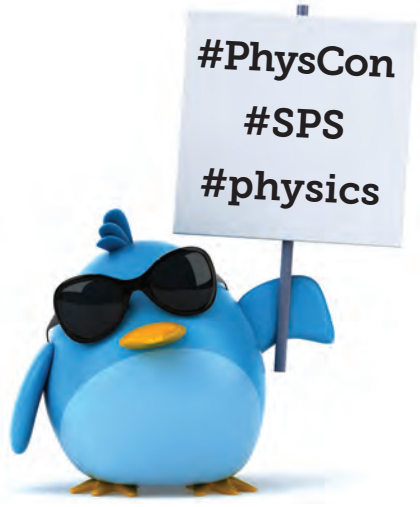
Poster Abstracts
Access the poster abstracts in the **PhysCon App** or on the PhysCon website at:

www.sigmapisigma.org/congress/2016/poster-presentations

Art Abstracts
Access the art abstracts in the **PhysCon App** or on the PhysCon website at:

www.sigmapisigma.org/congress/2016/art-contest

Please tag your social media posts with the #PhysCon hashtag.



Welcome, Congress Participants!

From the Planning Committee Chairs

Welcome! We are pleased, indeed thrilled, that you have joined us at the 2016 Sigma Pi Sigma Quadrennial Congress, also known as PhysCon. This is the only national meeting whose focus is on undergraduate physics students. We believe it is most appropriate that Sigma Pi Sigma, the national honor society in physics, is the host. The society knows that you hold this event in your hands and are the collective future of physics.

We've been working on this congress for the past four years and we're extremely proud of the program that we've put together. We are amazed by the great lineup of world-class speakers we will all enjoy. No physics student, young or young at heart, can avoid goose bumps when thinking of hearing Jocelyn Bell Burnell tell us of her discovery of pulsars or Eric Cornell's experimental realization of the condensate that Einstein and Bose predicted so many years ago. Oh, and there's Patrick Brady from LIGO who'll discuss their recent discovery of gravitational waves. The same can be said for our other speakers, true luminaries in our field. In short, we have an awesome lineup for you.

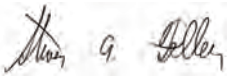
Some of you will get the chance to tour SLAC, where so many historic scientific discoveries have been, and continue to be, made. Others will see what the future holds as you visit Google X and hear about self-driving cars and balloon deployed Wi-Fi into remote areas.

Workshops on important contemporary issues await us all. Discussion and argument will help us form positions on several topics that concern us as good citizens, such as diversity in the discipline and communicating science to society, among a half-dozen or so topics. Don't forget to see the art exhibit and the hundreds of student posters. See what your colleagues have produced. Probe their work, ask questions; I'm sure the contributors will enjoy telling you of their accomplishments.

We urge you to meet new friends in physics, become immersed in physics from a wide viewpoint, and heartily enjoy this congress. Actually, it was designed with you in mind by fellow students, faculty, and AIP staff. Look around. Isn't this wonderful; where else will you see nearly 1200 physics students, alumni, and mentors together?

Welcome again,

William DeGraffenreid
California State University, Sacramento
Past president of Sigma Pi Sigma
Co-Chair, 2016 Sigma Pi Sigma Congress Planning Committee



Steve Feller
Coe College
Past president of Sigma Pi Sigma
Co-Chair, 2016 Sigma Pi Sigma Congress Planning Committee

From the Sigma Pi Sigma President

On behalf of Sigma Pi Sigma and the Society of Physics Students National Council, it is my esteemed HONOR to welcome you to the 2016 Sigma Pi Sigma Quadrennial Physics Congress—PhysCon!

As the largest meeting of undergraduate students in the US, PhysCon is many students' first professional conference and opportunity to experience **FELLOWSHIP** with the larger physics and astronomy community. The planning committee, led by Steve Feller and Bill DeGraffenreid, has been hard at work putting together the best PhysCon program ever. The speakers, workshops, exhibits, and tours of Silicon Valley have been thoughtfully crafted to inspire you. They are designed as **ENCOURAGEMENT** to increase your interests as physicists and to prepare you for professional lives of **SERVICE**. By nature, physicists are problem solvers who embody careers in all areas of society. It is my hope this PhysCon will motivate you to be an active member of your community, take ownership of your future, and help you reach out to others. Members of this pre-centennial congress will go into many fields seemingly unrelated to your current studies, but through physics, we can be the **UNIFYING FIELDS** leading to **SCIENCE DRIVING INNOVATION** for a better tomorrow.

Be blessed,

Willie S. Rockward
President, Sigma Pi Sigma
Morehouse College
Sigma Pi Sigma class of '86 (Grambling State University)

physcon
2016 Quadrennial Physics Congress

SPS

AIP
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Download the PhysCon App

Download on the App Store

GET IT ON Google Play

View program, share photos, see abstracts, and interact.

www.sigmapisigma.org/congress/2016/app

Sponsored by the American Astronomical Society.

AVS Student Activities

Did you know that 25% of AVS membership is comprised of students? You represent the future of AVS and we encourage you to take advantage of the following opportunities and services:

Student Chapters

Meet future colleagues and employers and form friendships while sharing common interests in a range of science and technology topics during various chapter activities.

Student Awards

Apply for both a **National and Divisional Level Award**. National Student Awards include **five top-level awards and multiple Graduate Research Awards**. All AVS National Student Awards are presented during the Awards Ceremony at the International Symposium and **include travel support as well as a cash award**.

Career Services

Connect with the finest job seekers and companies in physics, engineering, vacuum science, and technology using the **AVS Online Career Center** which partners with the Physics Today, American Association of Physics Teachers, American Physical Society, and IEEE Computer Society.

Attend our annual **Onsite Career Center/Mini Job Fair** at the AVS International Symposium and Exhibition and **meet with potential employers and gain interviewing skills during the conference**.

Short Courses

Broaden your knowledge and develop new job skills by attending an **AVS Short Course**. Courses offer basic and advanced training in vacuum, materials, processing, and interfaces.

AVS Publications and Technical Libraries

Delve into our **four journals that cover a variety of materials, processing, and interfaces topics**—access is easy using the online **AVS Publications Digital Library** or **iAVS**.

No time to attend a talk? Discover our newest benefit in the **AVS Technical Library, Presentations on Demand** featuring recorded talks from AVS Symposia. The Technical Library also provides access to books, monographs, and other scientific resource materials.

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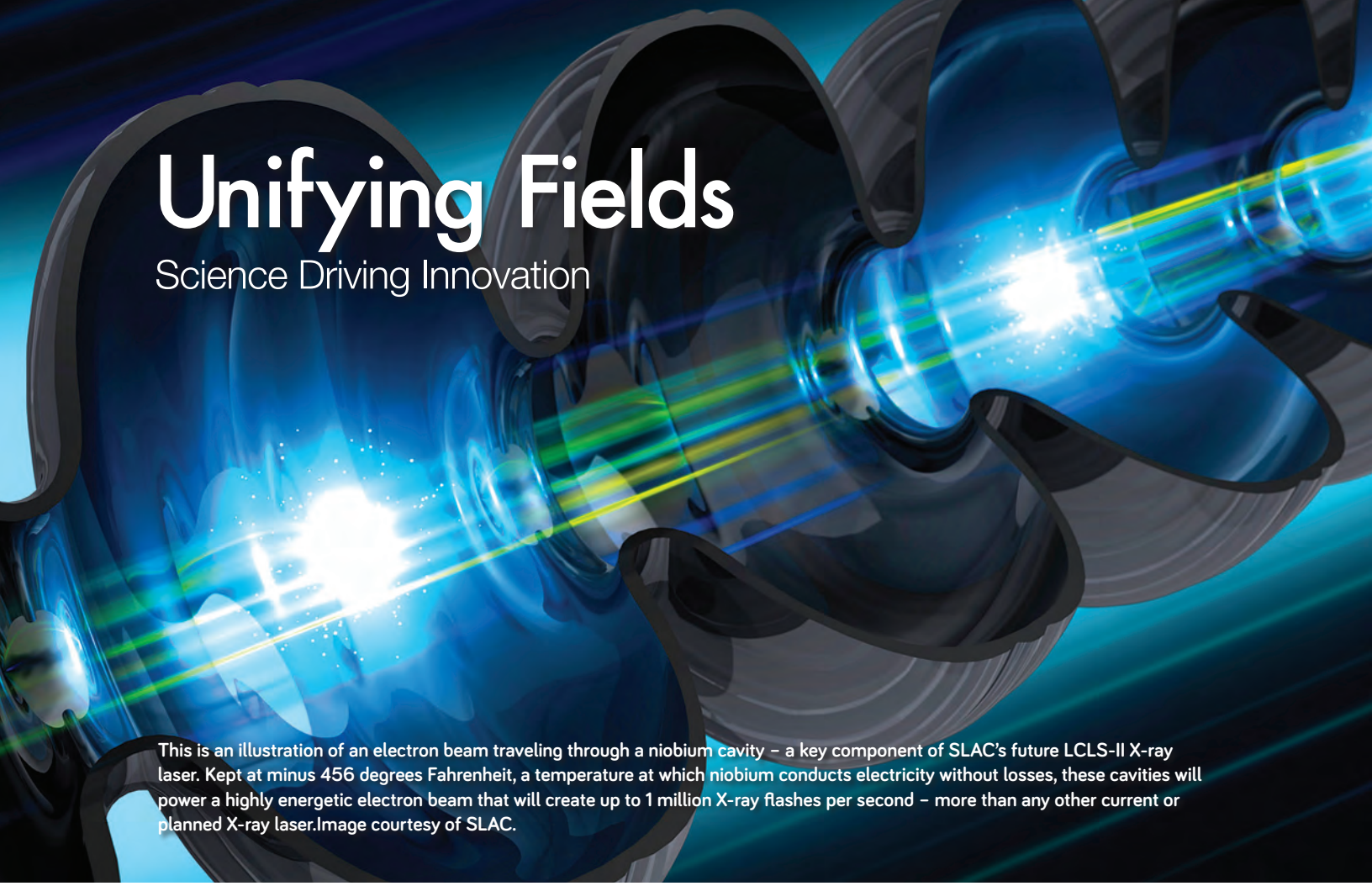
Unifying Fields

Science Driving Innovation



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

by Robert G. W. Brown, Chief Executive Officer, American Institute of Physics in College Park, MD

Innovation is the lifeblood of next-generation products, competitive business, growth, employment, and wealth creation. Modern physics research and development, as practiced in corporate and government research laboratories, deals heavily in applied science and engineering, often with a focus on the path to invention.

So important is the connection between science and innovation that the 2016 Quadrennial Physics Congress (PhysCon) will be devoted to the topic; our theme is "Unifying Fields: Science Driving Innovation."

Photo courtesy of AIP.

Innovation improves our quality of life, making possible a continuous stream of new technologies and better ways of doing things. But remember that innovation is a product of knowledge and discoveries accumulated over decades. Take an everyday example of an electronic mobile device—your smart phone or tablet. To bring such products to market, innovators successfully exploited advances in the physics of semiconductor devices, such as the creation of blue and green LEDs and laser diodes, progress in nano-micro silicon electronics, new kinds of liquid crystals, the development of ultrastrong glass, and the formulation of novel polymers. Display technologies and supercompact electronics are made possible by physics research done over the last 20 years—one could even argue 80 years—involving millions of dollars of up-front research investment. The payoff? Billions of dollars pumped into the global economy.

With this degree of return on investment (ROI), it seems obvious that sales revenue and taxes ought to be invested in future research to support the future economy. Yet today's Western world is reluctant to make serious investments or take the risks necessary for high payoff. As a result, we have limited our capacity to build competitive new products. Big R&D initiatives are unpredictable, expensive, and often beset with failures en route to successful innovation. Compared to our Asian competitors, who have come to dominate global manufacturing, we do not invest much in the translating of physics into devices and products. Much of the technology we purchase today comes from Asia, and that region benefits from the wealth creation. By diluting the investment and risk, we siphon the potential ROI.

The risks of translating science to products are so recognized that they inspired the term "Valley of Death," which refers to the probability that a start-up company will die before financiers can recoup their investments. The current trend is toward immediate or short-term payoffs, but we must advocate for the long term, the big investments in science that will help the United States maintain (or perhaps regain) its global leadership as an innovation superpower. //

Wednesday, November 2

8:00pm – 11:00pm: Registration

Location: Sandpebble A-D

Thursday, November 3

6:30am – 7:00pm: Registration

Location: Sandpebble A-D

6:30am – 6:00pm: Tour Departures and Arrivals

Location: Grand Peninsula Foyer (Staging Area)

MEET IN THE STAGING AREA AT THE FOLLOWING TIMES. Tours are about 5 hours in duration including travel time.
You must bring your ticket, and go on the tour location and time that you selected during registration.

6:30 am - SLAC National Accelerator Laboratory
8:45 am - SLAC National Accelerator Laboratory
9:15 am - Computer History Museum
10:45 am - SLAC National Accelerator Laboratory
11:15 am - Computer History Museum
11:15 am - X (Google's Moonshot Factory)
12:30 pm - California Academy of Sciences
12:45 pm - SLAC National Accelerator Laboratory

8:00am – 10:00am: Exhibit Setup

Locations: Regency Ballroom and Grand Peninsula Foyer

11:00am – 7:00pm: Exhibit Hall Open

Locations: Regency Ballroom and Grand Peninsula Foyer. *See exhibitor listings on pages 26-30.*

6:00pm – 7:00pm: Networking Reception in Exhibit Hall

Locations: Regency Ballroom

7:30pm – 8:00pm: Welcome & Opening Session

Location: Grand Peninsula Ballroom, Regency Foyer, Grand Peninsula Foyer

Willie Rockward, President, Sigma Pi Sigma
Jocelyn Bell Burnell, Honorary Congress Chair
Steve Feller, Congress Co-Chair

8:00pm – 9:30pm: Plenary I pg. 18

Location: Grand Peninsula Ballroom

Cosmic Fireworks – Finding Transient Events in the Universe
Jocelyn Bell Burnell, Honorary Congress Chair

Friday, November 4

7:00am – 5:00pm: Registration

Location: Sandpebble A-D

7:45am – 9:00am: Breakfast with the Scientists

Location: Atrium/Sequioa

9:15am – 10:45am: Plenary II pg. 18

Location: Grand Peninsula Ballroom

Universe
Neil Turok, 2016 Tate Medalist for International Leadership, Director of Perimeter Institute for Theoretical Physics

Presentation of AIP Tate Medal for International Leadership in Physics to Neil Turok

10:45am - 11:00am: Break

Location: Grand Peninsula and Regency Foyer

11:00am – 12:30pm: Workshop I pg. 24

Location: Grand Peninsula Ballroom

Unifying Fields – Science Driving Technology
Moderator: Randy Tagg, Associate Professor, Department of Physics, University of Colorado Denver
Liaisons: Toni Sauncy and William DeGraffenreid

12:30pm: Lunch

Location: Atrium/Sequioa

1:30pm – 2:45pm: Plenary III pg. 19

Location: Grand Peninsula Ballroom

Designing the Future of the Science and Innovation Ecosystem
Persis Drell, Dean of Stanford University School of Engineering and former Director of the SLAC National Laboratory

2:45pm – 5:00pm: Poster Session I and Art Show

Locations: Poster Session: Regency Ballroom Art Show: Harbor Room A

5:30pm – 6:30pm: Parallel Workshops IIa, IIb, and IIc pg. 24

Workshop IIa
Location: Grand Peninsula A-C

Taking Advantage of Physics Career Options
Leader: Toni Sauncy, Associate Professor and Department Chair, Texas Lutheran University
Moderator: William DeGraffenreid

Workshop IIb
Location: Grand Peninsula E-F

What is Grad School Really Like?
Panel Moderator: Chris Faesi, PhD candidate in Astronomy & Astrophysics, Harvard University
Liaison: Josh Willis

Workshop IIc
Location: Grand Peninsula D

Taking Your Chapter to the Next Level
Leader: Gary White, American Association of Physics Teachers and The George Washington University
Moderator: DJ Wagner

8:30pm – 10:30pm: Silicon (Si): The PhysCon Dance Party

Location: Pool Pavilion

Sponsored by the American Physical Society

Saturday, November 5

8:00am – 2:00pm: Registration

Location: Sandpebble A-D

8:30am – 10:00am: Plenary IV pg. 20

Location: Grand Peninsula Ballroom

L'arte della fisica (The Art of Physics), Accessing My Creativity App
S. James Gates, Distinguished Prof. and Center for String and Particle Theory Director at the University of Maryland

10:00am – 10:30am: Break

Location: Grand Peninsula and Regency Foyer

10:30am - 12:00noon: Parallel Workshops IIIa, IIIb, and IIIc pg. 25

Workshop IIIa
Location: Grand Peninsula D

Making Physics a Community
Leader: Therese Jones, Assistant Policy Analyst, Ph.D Candidate, Pardee Graduate School
Liaison: William DeGraffenreid

Workshop IIIb
Location: Grand Peninsula A-C

Oh the Jobs that Physics Can Lead to ...
Moderator: Deval Mehta, MA Candidate, Dept. of Physics and Astronomy, Stony Brook University
Liaison: Steve Feller

Workshop IIIc
Location: Grand Peninsula E-G

Communicating Science to the Public with Superheroes
James Kakalios, School of Physics and Astronomy, The University of Minnesota
Rebecca Thompson, American Physical Society
Liaison: Toni Sauncy

12:00pm - 1:00pm: Lunch

Location: Atrium/Sequioa

1:00pm – 2:30pm: Workshop IV pg. 25

Location: Grand Peninsula Ballroom

Put PhysCon in Action at Home
Leaders: William DeGraffenreid, Professor of Physics at Sacramento State and Past President of Sigma Pi Sigma and **Brad Conrad,** Director of SPS and Sigma Pi Sigma. **Liaison: Toni Sauncy**

2:30pm – 2:45pm: Break

Location: Grand Peninsula and Regency Foyer

2:45pm – 4:00pm: Plenary V pg. 21

Location: Grand Peninsula Ballroom

Particle Paleontology: Looking for Fossils from the Early Universe Inside the Electron
Eric Cornell, Senior Scientist at JILA, NIST and the Dept. of Physics, University of Colorado at Boulder, 2001 Physics Nobel Laureate

4:00pm – 6:00pm: Poster Session II and Art Show

Locations: Poster Session: Regency Ballroom Art Show: Harbor Room A

6:30pm – 8:00pm: Banquet

Location: Grand Peninsula Ballroom

Presentation of the AIP 2016 Andrew Gemant Award to James Kakalios
Presentation of the AIP 2016 Prize for Industrial Applications of Physics to Hendrick Hamann
Poster and Art Competition Awards

8:00pm – 9:30pm: Plenary VI pg. 22

Location: Grand Peninsula Ballroom

The Dawn of Gravitational-wave Astronomy
Patrick Brady, Prof. and Director, Center for Gravitation, Cosmology & Astrophysics, Univ. of Wisconsin, Milwaukee, LIGO Team Member

Sponsors

Thank You PhysCon Sponsors

The Friday evening PhysCon dance party is brought to you by the American Physical Society, a non-profit membership organization working to advance and diffuse the knowledge of physics through its outstanding research journals, scientific meetings, and education, outreach, advocacy and international activities.
www.aps.org

The PhysCon app was sponsored by the American Astronomical Society, the major organization of professional astronomers in North America. Its membership of about 8,000 also includes physicists, mathematicians, geologists, engineers, and others whose research and educational interests lie within the broad spectrum of subjects comprising contemporary astronomy.
http://aas.org

The outstanding student poster awards and art contest awards were provided by the OSA Foundation, the charitable organization working on behalf of The Optical Society (OSA). The OSA Foundation has funded hundreds of programs for future and emerging scientists benefiting thousands of individuals in more than 55 countries.
www.osa-foundation.org

The registration bags were provided by Newport Corporation, a leading global supplier of advanced technology products and systems to customers in the scientific research, microelectronics, life and health sciences, industrial manufacturing and defense/security markets.
www.newport.com

The name badge lanyards and general support for PhysCon were provided by Hamamatsu Corporation, a major developer and manufacturer of photomultiplier tubes, imaging devices, light sources, opto-semiconductors, and imaging and analyzing systems.
www.hamamatsu.com

The PhysCon Student Travel Fund was funded in part by Associated Universities Incorporated, which collaborates with the scientific community and research sponsors to plan, build, and operate cutting-edge facilities.
www.aui.edu

The PhysCon Student Travel Fund was funded in part by the American Association of Physicists in Medicine, a scientific and professional organization dedicated to ensuring accuracy, safety and quality in the use of radiation in medical procedures such as medical imaging and radiation therapy.
www.aapm.org

The PhysCon Student Travel Fund was funded in part by the American Association of Physics Teachers, the premier organization representing and supporting physics and physical science teachers and teaching in the United States.
www.aapt.org

In-kind subscriptions to the Wolfram|Alpha computational knowledge engine for PhysCon award recipients was provided by Wolfram Research, Inc., one of the world's most respected computer, web, and cloud software companies—as well as a powerhouse of scientific and technical innovation.
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www.thorlabs.com

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Unifying Fields
Science Driving Innovation

Planning Committee & Staff

2016 Quadrennial Physics Congress Planning Committee

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Steve Feller, Coe College (Congress Co-chair)
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Brittney Hauke, Coe College
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About the Society of Physics Students, Sigma Pi Sigma, and the American Institute of Physics

The **Society of Physics Students** (SPS) is a professional association explicitly designed for students. Membership, through collegiate chapters, is open to anyone interested in physics. The only requirement for membership is that you be interested in physics. In addition to physics majors, our members include majors in chemistry, computer science, engineering, geology, mathematics, medicine, and a range of other fields.

SPS exists to help students, particularly undergraduates, transform themselves into contributing members of the professional community. Course work develops only one range of skills. Other skills needed to flourish professionally include effective communication and personal interactions, leadership experience, establishing a personal network of contacts, presenting scholarly work in professional meetings and journals, and outreach services to the campus and local communities. Locally, regionally, nationally, and internationally, the SPS offers the opportunity for these important enrichments to the student's experience.

Within SPS is housed **Sigma Pi Sigma**, the national physics honor society, which elects members on the basis of outstanding academic achievement. Sigma Pi Sigma exists to honor outstanding scholarship in physics; to encourage interest in physics among students at all levels; to promote an attitude of service of its members towards their fellow students, colleagues, and the public; to provide a fellowship of persons who have excelled in physics. Sigma Pi Sigma's mission is not fulfilled by the induction ceremony, which recognizes academic accomplishment. In the four dimensions of **Honor, Encouragement, Fellowship,** and **Service**, the mission of Sigma Pi Sigma spans a lifetime.

Founded in 1921, Sigma Pi Sigma is a member honor society of the Association of College Honor Societies. Our society has more than 85,000 historical members. Election to Sigma Pi Sigma is a lifetime membership.

This unique two-in-one society operates within the **American Institute of Physics** (AIP), a federation of physical science societies that advances, promotes and serves the physical sciences for the benefit of humanity. AIP offers authoritative information, services, and expertise in physics education and student programs, science communication, government relations, career services for science and engineering professionals, statistical research in physics employment and education, industrial outreach, and the history of physics and allied fields. AIP also publishes the flagship magazine *Physics Today* and is home to the Niels Bohr Library and Archives. AIP owns AIP Publishing LLC, a scholarly publisher in the physical and related sciences.

The ten Member Societies supported by AIP collectively represent a broad cross-section of more than 120,000 scientists, engineers, and educators in the global physical science community.

Sigma Pi Sigma Congresses

The 2016 Quadrennial Physics Congress (PhysCon) taking place this week in San Francicso, CA and the Silicon Valley, is the latest in of a long line of congresses hosted by Sigma Pi Sigma. Congresses have played an integral role in the development of Sigma Pi Sigma as an honor society, and, while the meeting has evolved over the years, one of its core purposes has stayed the same: to provide direction and vision to Sigma Pi Sigma.

The first congress was held in 1928 at Davidson College in North Carolina, and six chapters attended. They elected national officers, including Marsh White who became a lifelong active participant in Sigma Pi Sigma. In 1934, the third congress was held at the University of Kentucky, attended by nineteen chapters. During this congress Sigma Pi Sigma transitioned from a fraternity to an honor society and set the standard that membership was dependent on academic excellence. In 1967, a special congress saw ninety chapters vote to merge Sigma Pi Sigma with the American Institute of Physics, a move that gave birth to the Society of Physics Students.

In 1992, Sigma Pi Sigma hosted the first congress in 25 years, in Dayton, Ohio—often referred to as the first modern congress. The primary reason that congresses restarted in 1992 was to determine the feasibility of a 75th anniversary celebration in 1996. Based on the success of the 1992 meeting, plans moved forward.

The 1996 "Diamond Jubilee" congress celebrated the 75th anniversary of the founding of Sigma Pi Sigma and addressed the theme "Looking Back, Looking Forward." Held in Atlanta, Georgia, participants heard from exciting speakers such as Dr. Robert Ballard and Dr. Alan Lightman, and the tradition of hosting small group discussions or "breakout sessions" was started.

The 2000 congress in College Park, Maryland, fully implemented breakout sessions, celebrated the unique creativity of Sigma Pi Sigma members, and featured a large-scale discussion on the state of diversity in physics. Attendees didn't just talk about important issues; they made recommendations to the physics community at large about the state of physics and physics education through the National Task Force on Undergraduate Physics.

The 2004 Congress, held in Albuquerque, New Mexico, set the direction for future congresses. It included tours of the Trinity Test Site in the Jornada del Muerto Desert, and developed ten recommendations related to ethical conduct for Sigma Pi Sigma and the Society of Physics Students. Breakout sessions became full-fledged workshops where attendees discussed important topics such as "Career Choices & Weapons Research" and "Professional Integrity in Research & Authorship," for example.

Four years later at Fermilab in Batavia, Illinois, the 2008 Congress addressed the theme of "Scientific Citizenship: Connecting Physics & Society." Over 600 people attended this congress, setting forth recommendations that led to a renewed commitment by Sigma Pi Sigma and the Society of Physics Students (SPS) to encourage diversity in physics. These recommendations led to the creation of the Future Faces of Physics initiative, which includes a $500 award for SPS chapters to hold events that cross cultural divides. The 2008 congress also included an art contest, where attendees displayed and shared art connected to science.

The 2012 Congress, held in Orlando, FL, was built around the theme "Connecting Worlds Through Science and Service." More than 800 attendees enjoyed a kick-off tour of the NASA-Kennedy Space Center, and heard from science luminaries including Freeman Dyson and Physics Nobel Laureate. Dr. John Mather. The meeting also included the first dance party, a tradition being continued at the 2016 congress. Service has been an integral part of Sigma Pi Sigma since the 1934 congress, when it was written into the society's mission. Many members and chapters are extremely active in their community, and former president Diane Jacobs said it best: "On the brochure students receive when they are invited to join Sigma Pi Sigma are printed the following words: honor, encouragement, fellowship, and service. These are the cornerstones of our physics honor society." Sigma Pi Sigma members take their responsibility to serve their community to heart, and the 2012 congress theme was an extension of that dedication.

Each congress helps guide the next, and the theme developed for the 2016 Quadrennial Physics Congress, "Unifying Fields: Science Driving Innovation," fed off the energy and direction of past congresses.

Sigma Pi Sigma's Quadrennial Physcis Congress has become the largest and most unique meeting targeted at undergraduate physicists in the United States, bringing together undergraduate and graduate physics students, faculty, alumni, and others. In addition to exciting plenary talks, attendees engage in productive and important discussions on relevant physics topics. The 2016 Physics Congress (or PhysCon) will focus on "Science Driving Innovation" through six plenary talks, eight workshops, two poster sessions, an art contest, tours of local science and technolgoy sites, networking opportunities, and an exhibit hall packed with graduate school representatives, physics professional societies, and other organizations. These events help provide an atmosphere for attendees to grow and develop as members of the community, as well as providing important guidance and feedback for Sigma Pi Sigma and SPS.

–by Sigma Pi Sigma staff

RIGHT
The first Sigma Pi Sigma national convention, held on the campus of the founding chapter, Davidson College, NC. Six chapters were represented, national officers were elected, and life-long leader Marsh White (first row, far left) became Secretary/Treasurer. Photo courtesy of American Institute of Physics.

Tour Guidelines

The PhysCon tours on November 3, 2016, have strict entry requirements, as outlined below, which will be enforced, especially those related to citizenship and ID requirements. Failure to comply with the requirements could mean forfeiting the tour opportunity. Only those who are fully registered as meeting attendees can go on the tours. All tours are approximately two hours in length with anticipated transportation times of one hour each way.

Roundtrip shuttle service is provided to transport attendees from the Hyatt Hotel to the tour sites. **ATTENDEES MUST MEET IN THE STAGING AREA (GRAND PENINSULA FOYER) AT THE LISTED TIMES. Do not miss the provided transportation or you must get yourself back to the conference hotel at your own expense.**

SLAC National Accelerator Laboratory

There are four scheduled tours to SLAC. Each tour can accommodate 100 participants. The departure schedule is: 6:30 a.m., 8:45 a.m., 10:45 a.m., and 12:45 p.m.

Description: The SLAC Tour will include an overall orientation to the Accelerator Laboratory and tours of the Klystron Gallery (2-mile-long accelerator), the Viz Lab (3D visualization laboratory testing theories on dark matter), the Linac Coherent Light Source (revolutionary x-ray laser), and the Stanford Synchrotron Radiation Light source. Not all tours will be exactly the same and the components of each tour will vary.

Entrance Requirements

- Must be over 18 years of age.
- You must have provided to PhysCon 2016 by October 20th, your full name, country of citizenship, and if not a US citizen, your country of birth.
- All participants must have a US government issued ID to enter (Driver's License or other U.S. government picture ID).
- All Students will need to wear closed toe shoes (absolute requirement).

Google [X] Tour

There will be one tour to Google [X] departing from the hotel at 11:15 a.m. with maximum participation of 200.

The Google X lab is where Google explores new technology such as a self-driving car, internet enabled contact lenses, a space elevator and a hoverboard. We will visit the Google [X] headquarters in Mountain View, California. There will be educational talks about Project Loon and other projects.

Entrance Requirements

- You must be over 18 years of age.
- Participants must always be with an escort.
- You may not enter into unauthorized areas.
- There is absolutely no photography, videotaping or recording allowed.

California Academy of Sciences Tour

There will be one tour to the California Academy of Sciences. The tour can accommodate a maximum of 200 students. Shuttle buses depart from the Hyatt Regency at 12:30 p.m.

The California Academy of Sciences is a renowned scientific and educational institution dedicated to exploring, explaining, and sustaining life on Earth. Based in San Francisco's Golden Gate Park, it is home to a world-class aquarium, planetarium, and natural history museum—all under one living roof. This self-guided tour will consist of some of the following highlights: the newly redone Morrison Planetarium, Kimball Natural History Museum, Osher Rainforest, and Steinhart Aquarium.

Entrance Requirements

- All students will need a student ID to enter.
- There is only one pick up and drop off time.

Computer History Museum

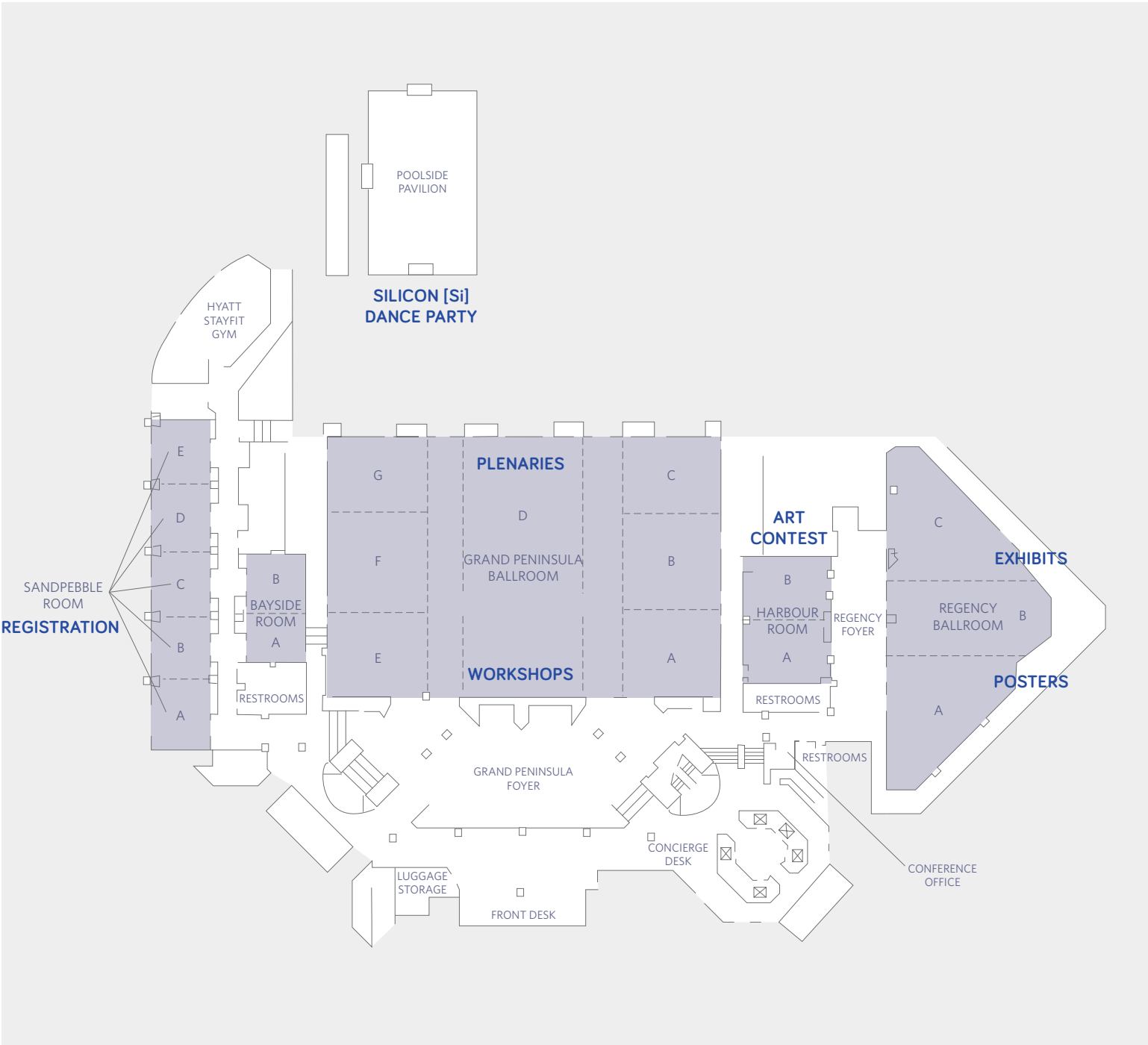
There will be two morning tours to the Computer History Museum. Each self-guided tour can accommodate a maximum of 100 students. Shuttle buses depart from the Hyatt Regency at 9:15 a.m. and 11:15 a.m.

From their website: Spend a day at the Computer History Museum. Find out why computer history is 2000 years old. Learn about computer history´s game-changers in our multimedia exhibitions. Play a game of Pong or Spacewar! Listen to computer pioneers tell their story from their own perspective. Discover the roots of today´s Internet and mobile devices. See over 1,100 historic artifacts, including some of the very first computers from the 1940s and 1950s.

Entrance Requirements

- All students will need an ID to enter.
- Plan for two hours at the event.
- This tour includes a 10% discount at the gift shop.

Lobby Level



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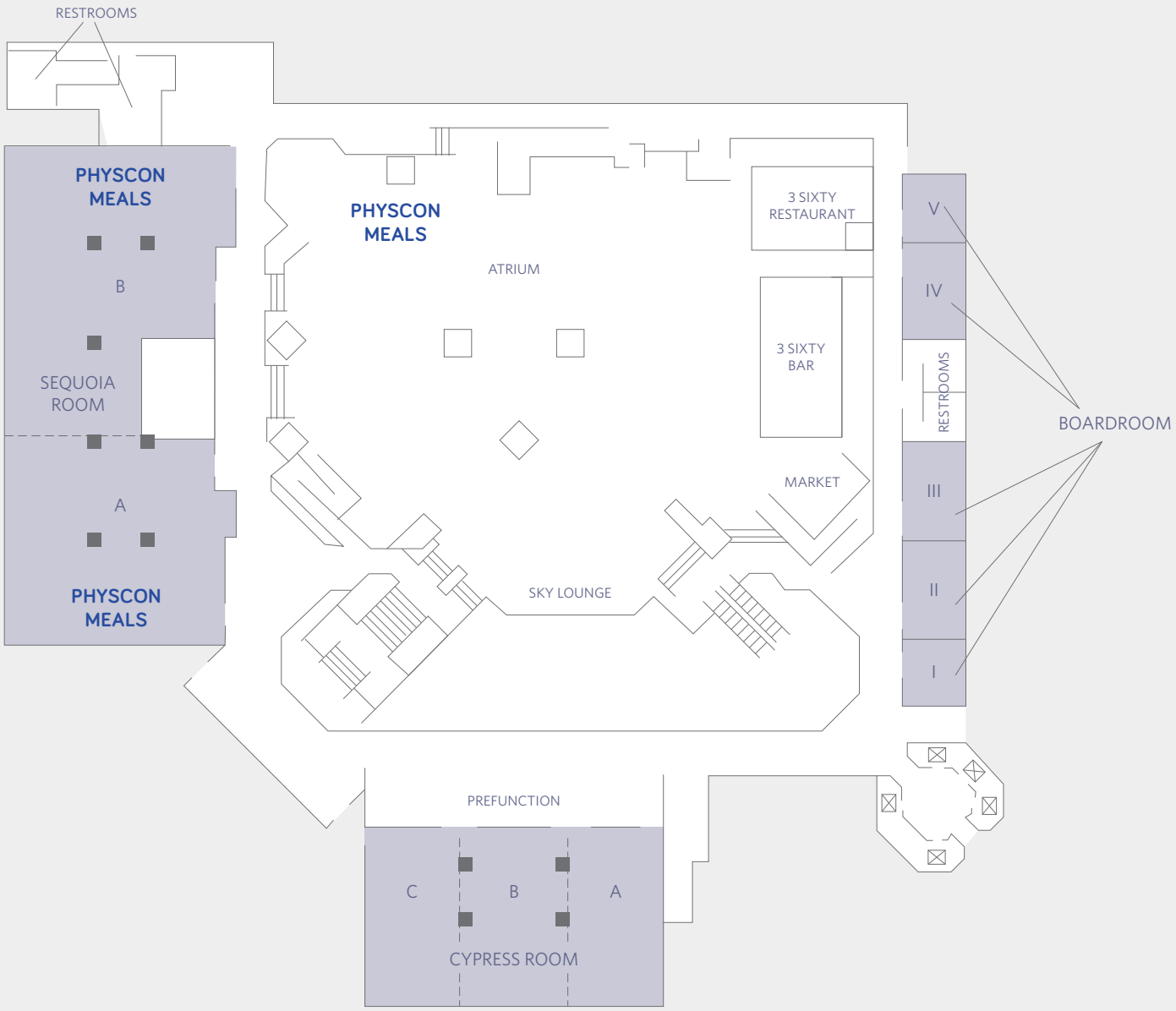

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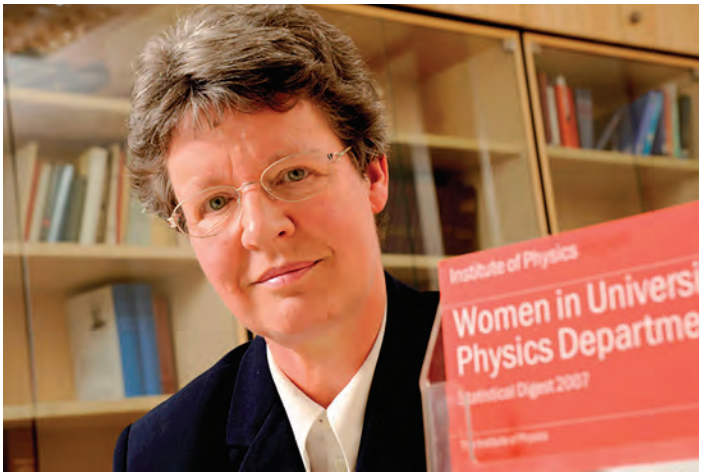
JOCELYN BELL BURNELL, HONORARY CHAIR

Plenary I: Cosmic Fireworks – Finding Transient Events in the Universe

Often when we view the Universe in a new way, new and unexpected phenomena are discovered. Recent developments in detectors (for example CCDs) and in computers are now allowing astronomers to search systematically for short duration phenomena – flares, bursts and other kinds of changes in the brightness of stars and galaxies. Some such phenomena were already known (supernovae, for example), and some have been accidentally discovered (gamma ray bursts, for example). There has also recently been more systematic searching for moving objects, such as asteroids that might impact the earth.

We are now entering a new phase with more and bigger telescopes, larger data flows, and observations with new, lower frequency, radio telescopes. This talk will describe this burgeoning field and speculate on what might be found.



Jocelyn Bell Burnell. Photo courtesy of Jocelyn Bell Burnell.

No Asking, Just Telling

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 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."

—by Rachel Kaufman

NEIL TUROK

Plenary II: Universe

A spate of new observations are providing powerful clues about the laws of fundamental physics and the cosmos. The implications are revolutionary: the universe is astonishingly simple on the largest and the smallest observable scales, with great complexity in between. These findings contrast sharply with expectations from popular twentieth century paradigms including inflation, supersymmetry and string theory, which led many to take seriously the idea of a wild and unpredictable "multiverse" on large scales. Key "predictions" derived from that picture have been recently falsified, posing observational challenges to the paradigm which compound its many logical problems. In this talk I will discuss a new, and in my view more promising, approach to understanding the quantum nature and integrity of the universe.

Neil Turok. Photo by Deb Baic, The Globe and Mail.

Rebel, Rebel: Neil Turok Builds a Career on Investigating The "Unpopular"

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 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.

—by Rachel Kaufman

PERSIS DRELL

Plenary III: Designing the Future of the Science and Innovation Ecosystem

I will discuss the critical steps we must be taking to ensure the future success of the science and innovation ecosystem in the United States. This will include an analysis of changing scientific opportunities, changing perceptions of science and the foundational role that diversity of thought and approach will contribute to our success.

Persis Drell. Photo courtesy of SLAC National Accelerator Laboratory.

Persis Drell Keeps Asking the Big Questions

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, whose leadership in the international particle physics community is renown. 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?"

Daughter of 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 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.

—by Rachel Kaufman

S. JAMES GATES

Plenary IV: L'arte della fisica (The Art of Physics), Accessing My Creativity App

We will take on a journey through creativity in fundamental physics, art and music, through the work of a theoretical physicist seeking mathematical magic.

S. James Gates. Photo by Sarah L. Voisin/The Washington Post via Getty Images.

The Universe According to Jim Gates

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 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 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 PhD there four years later. His dissertation was the first written about supersymmetry at MIT, 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."[4]

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."[5]

"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."[6]

Until then, Gates will keep looking.

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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 McMaster, *NOVA*, 2003.

5 Ibid.

6 Ibid.

—by Rachel Kaufman

ERIC CORNELL

Plenary V: Particle Paleontology: Looking for Fossils from the Early Universe Inside the Electron

In the earliest instants of the universe, a tiny but essential deviation from perfect symmetry made possible the existence of the universe we now live in. Fourteen billion years later, is it possible to find a "fossil" left over from that fateful early imperfection? In an effort to answer that question, we are taking a very very close look at the humblest and most commonplace particle, the electron.

Eric Cornell and His Cool Condensate

Photo courtesy of Eric Cornell.

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 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, Reagan-esque 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.

—by Rachel Kaufman

PATRICK BRADY

Plenary VI: The Dawn of Gravitational-wave Astronomy

On September 14, 2015 at 09:50:45 UTC the two detectors of the Laser Interferometer Gravitational-Wave Observatory simultaneously observed a transient gravitational-wave signal. The signal swept upwards in frequency from 35 to 250 Hz and matched the waveform predicted by general relativity for the inspiral and merger of a pair of black holes and the ringdown of the resulting single black hole. This first observation of gravitational waves from colliding black holes was followed by another in late December 2015. These observations signaled the dawn of gravitational-wave astronomy. I will discuss the century-long path to this remarkable breakthrough, what we have learned from these first observations, and where we go from here.

For Patrick Brady, LIGO's Success Is Just The Beginning

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.'"

Photo courtesy of Patrick Brady.

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 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."

—by Rachel Kaufman

WORKSHOP I: UNIFYING FIELDS—SCIENCE DRIVING INNOVATION

Building off of the words from Professor Freeman Dyson, "the big challenge for physics in the next 50 years – your lifetimes – is building tools for other people to use", this workshop will focus on connecting you with another great challenge: enabling a large portion of global human population to have a role in these revolutions and a way to gain from them. This highly interactive workshop will provide you with the skills necessary to imagine the tools and innovations of coming generations and enable discovery for those all over the world. Special focus will be given to what can be done today to imagine the future of tomorrow.

Leader:

Randy Tagg,
Associate Professor, Department of Physics,
University of Colorado Denver

Liaisons: Toni Sauncy and William DeGraffenreid

WORKSHOP IIa: TAKING ADVANTAGE OF PHYSICS CAREER OPTIONS

This workshop will focus on professional development tools for undergraduate physics students that have been developed as part of the American Institute of Physics Career Pathways research project†. More than 40% of all undergraduate physics majors enter the workforce after graduation, despite the fact that many undergraduate physics programs do not include experiences aimed at making sure students are ready to find the career of their dreams. You will engage with new resources, made just for physics students and developed with the goal of putting you ahead of the crowd when it comes to building your professional network. You will also learn to better recognize the unique set of skills that you have or will acquire in completing your undergraduate physics program. You will work on developing those important soft skills and learn effective techniques for articulating your hard skills to those who may not be fully aware of all that a well-prepared physics student is capable of. Even if you do not plan to go to work immediately after graduation, you will still benefit from this unique session focused on putting your best foot forward when you when you are ready to find your first position!

† Funded through NSF Grant No. 1011829

Leader:

Toni Sauncy,
Associate Professor and Department Chair,
Texas Lutheran University

Liaison: William DeGraffenreid

WORKSHOP IIb: WHAT IS GRAD SCHOOL REALLY LIKE?

If you're pondering graduate school as the next step in your career, but aren't sure what kind of program to choose, or what your life will be like, then come to this panel and hear the experiences of several current graduate students. Find out about the different reasons to choose master's versus doctoral programs, and between general physics or a speacialized field. Learn how to apply, what to look for in choosing from the schools where you get in, and how to balance the rest of your life with the demands of graduate school once you get there.

Panel Moderator:

Chris Faesi,
PhD candidate in Astronomy & Astrophysics,
Harvard University

Liaison: Josh Willis

WORKSHOP IIc: TAKING YOUR CHAPTER TO THE NEXT LEVEL

Do you have an active, busy chapter, but know it can do more? Do you struggle to get members to come to your meetings, and wonder what your chapter should be doing together? Just as a quantum system cannot emit photons from the ground state, your chapter can only shine when it has risen to higher levels, to excited states. Come to this workshop and Dr. Gary White, former director of the Society of Physics Students, will present ideas to inspire your chapter, and make it active in outreach, meetings, and professional development. In this workshop you will identify strengths and weaknesses of your chapter, engage with other chapters to learn what works for them, and leave with a concrete action plan to take back to your chapter, reaching those excited states from which your chapter can really shine.

Leader:

Gary White,
American Association of Physics Teachers and
The George Washington University

Moderator: DJ Wagner

WORKSHOP IIIa: MAKING PHYSICS A COMMUNITY

Have you ever felt stressed in your physics program? Wish that you could make a change, but feel no one is listening? The aim of this workshop is to empower undergrads to be the change they want to see in their department, and brainstorm ideas on way to improve the climate, addressing everything from increasing the participation of traditionally underrepresented groups to making sure that everyone knows about free conference funding! After a short introduction, students will get into breakout groups where they will examine issues important to them/their department, come up with concrete ways to implement change, and share their results in written form with the broader conference so that every SPS chapter can take away fresh ideas on improving the physics world for students.

Leader:

Therese Jones,
Assistant Policy Analyst, Ph.D Candidate,
Pardee Graduate School

Liaison: William DeGraffenreid

WORKSHOP IIIb: "OH THE JOBS THAT PHYSICS CAN LEAD TO..." (PANEL)

When getting a degree in physics, the most common vision for a career is in academia or teaching. While many go into these fields, they represent only a portion of the career opportunities with a physics degree. We've put together a panel of physicists who are in a career that you may not have thought about. They will share their pathways and answer your questions.

Panel Moderator:

Deval Mehta,
MA Candidate,
Department of Physics and Astronomy,
Stony Brook University

Liaison: Steve Feller

WORKSHOP IIIc: COMMUNICATING SCIENCE TO THE PUBLIC WITH SUPERHEROES

Inspired by the popular science book THE PHYSICS OF SUPERHEROES, 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. For example, was it "the fall" or "the webbing" that killed Gwen Stacy, Spider-Man's girlfriend in the classic Amazing Spider-Man #121? What is the connection between the Marvel comics' super villains Electro and Magneto (and which one is associated with electricity, and which one with magnetism?). How do various characters turn invisible, and how do they manage to see when transparent? In addition to having many more scans from comic books and clips from Hollywood blockbusters than the standard physics talk, this workshop will involve hands on demonstrations that illuminate the topics discussed. All this, and the answers to such important real life questions as the chemical composition of Captain America's shield, and who is faster: Superman or the Flash? will be discussed.

Leaders:

James Kakalios,
School of Physics and Astronomy,
The University of Minnesota

Rebecca Thompson,
American Physical Society

Liaison: Toni Sauncy

WORKSHOP IV: PUT PHYSCON IN ACTION AT HOME

New members of Sigma Pi Sigma are charged to support the physics community and to assist the development of interest in physics at all possible levels. These ideals equally apply to SPS chapters and physics clubs the world over. In this session we'll examine ways a chapter can cultivate interest in physics and how you can you share your fascination with physics to as wide an audience as possible. You'll work with others in your chapter and zone to bring together the tools you've learned over the past few days and develop a plan on how you'll bring it to others that were not able to join us. Together we can make each SPS chapter a vibrant place where we can help our fellow physics enthusiasts, tinker, invent, and discover. And, we can do it all together.

Leaders:

William DeGraffenreid,
Professor of Physics,
Sacramento State
Past President of Sigma Pi Sigma

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

Liaison: Toni Sauncy

Please tag your social media posts with the #PhysCon hashtag.

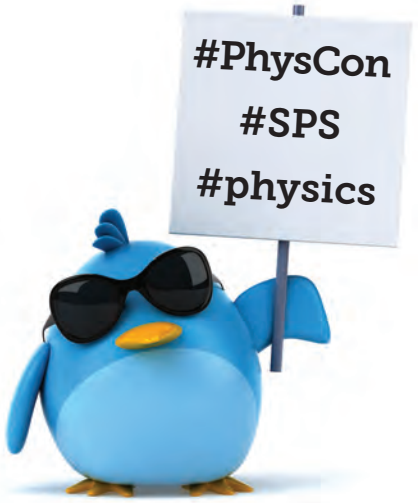


Exhibit Locations

Exhibit booths 1 - 25 will be located in the Regency Ballroom during the Exhibit Hall on Thursday, November 3, from 11:00 am – 7:00 pm.
Exhibit booths 100 - 105 will be located in the Grand Peninsula Foyer throughout the meeting.

Acoustical Society of America

Booth Number: 1
Contact: L. Keeta Jones, kjones@acousticalsociety.org, 516-576-2364
Website: acousticalsociety.org

The Acoustical Society of America (ASA) is the premier international scientific society in acoustics. Its purpose is to generate, disseminate, and promote the knowledge and practical applications of acoustics. A variety of fields related to sound are represented such as physics, oceanography, noise control and many more. The Society is a voluntary organization and attracts the interest, commitment, and service of a large number of professionals, academics, and students from around the world. Their contributions in the guidance, administration, and development of the ASA are largely responsible for its world-wide preeminence in the field of acoustics.

Air Force Institute of Technology, Department of Engineering Physics

Booth Number: 2
Contact: Omar Nava, omar.nava@afit.edu, 937-295-3636 x 4518
Website: www.afit.edu/enp

The Air Force Institute of Technology is focused on basic science and applied technologies for the Department of Defense. The graduate programs emphasize practical research and its transition into operations within the United States Air Force, Department of Defense, and other government agencies.

American Association of Physicists in Medicine

Booth Number: 3
Contact: Rachael Smiroldo, rachel@aapm.org, 571-298-1230
Website: www.aapm.org

The American Association of Physicists in Medicine is a professional membership organization of more than 8,000 members. The mission of AAPM is to advance the science, education & professional practice of Medical Physics; a broad-based scientific & professional discipline, encompassing physical principles with applications in biology & medicine.

American Crystallographic Association

Booth Number: 4
Contact: Marcia Colquhoun, aca@hwi.buffalo.edu, 716-856-8692
Website: www.amercrystalassn.org

The American Crystallographic Association, Inc. is a non-profit, scientific organization of over 1,000 members in more than 35 countries. ACA was founded in 1949 through a merger of the American Society for X-Ray and Electron Diffraction (ASXRED) and the Crystallographic Society of America (CSA). The objective of the ACA is to promote interactions among scientists who study the structure of matter at atomic (or near atomic) resolution. These interactions will advance experimental and computational aspects of crystallography and diffraction. Understanding the nature of the forces that both control and result from the molecular and atomic arrangements in matter will help shed light on chemical interactions in nature and can therefore lead to cures for disease. Membership in the ACA is open to any person who is actively interested in the purposes of the Association. Student members are very welcome and their contributions to the life and vigor of the Association has always been important. Meetings are held annually in July. There are 12 Scientific Interest Groups concerned with Biological Macromolecules, Fiber Diffraction, General Interest, Industrial, Materials Science, Neutron Scattering, Powder Diffraction, Service Crystallography, Small Angle Scattering, Small Molecules, Synchrotron Radiation and Young Scientists. Members may join as many of these as they wish. Each Scientific Interest Group is responsible for organizing sessions at National Meetings.

American Meteorological Society

Booth Number: 26
Contact: Beth Farley, bfarley@ametsoc.org, 617-226-3910
Website: ametsoc.org/ams

The American Meteorological Society (AMS) is the nation's premier scientific and professional organization promoting and disseminating information about the atmospheric, oceanic, hydrologic sciences. AMS is committed to strengthening the incredible work being done across the public, private, and academic sectors. Our community knows that collaboration and information sharing are critical to ensuring that society benefits from the best, most current scientific knowledge and understanding available.

California State University, Fresno

Booth Number: 5
Contact: Roger Key, rogerk@csufresno.edu
Website: www.fresnostate.edu

California State University, Fresno invites you to do your graduate study (MS Physics) with world class research, small class size, and individual attention. Our faculty do research in the areas of high energy physics (CERN-ATLAS program), medical physics (multidimensional magnetic resonance spectroscopy and biological applications of x-ray fluorescence), astrophysics (cataclysmic variable binary stars), condensed matter physics (synthesis of semiconducting nanowires and advanced materials), and theoretical physics (quantum field theory, gravitation, cosmology, and particle physics). For more information, visit: http://fresnostate.edu/csm/physics/index.html.

Delaware State University

Booth Number: 6
Contact: Thomas Planchon, tplanchon@desu.edu
Website: www.desu.edu

Duke University Medical Physics Graduate Program

Booth Number: 7
Contact: Anju Kapadia, anuj.kapadia@duke.edu, 919-684-1442
Website: medicalphysics.duke.edu

We are a CAMPEP accredited program in Medical Physics and one of the few that equally emphasizes all major areas of medical physics: diagnostic imaging, nuclear medicine, medical health physics, and radiation therapy. In addition to our diverse and flexible program curriculum, our students receive advanced clinical, research, and professional training to customize their education to future career goals.

Florida Polytechnic University

Booth Number: 8
Contact: Sherrita Denson, sdenson@flpoly.org, 863-874-4776
Website: floridapolytechnic.org

Florida Polytechnic University is the newest university in the State University System of Florida. It is also Florida's only public university wholly dedicated to science, technology, engineering, and mathematics (STEM). Florida Poly provides students with hands-on learning, applied research opportunities, industry connections and the ability to work on real-world problems under the guidance of distinguished faculty with experience in both industry and academia.

Georgia State University

Booth Number: 9
Contact: Alexander Kozhanov, akozhanov@gsu.edu
Website: www.gsu.edu

Our research groups span the range from exploring the constituents of matter at the subatomic and nuclear levels to the formation and evolution of active galaxies. Departmental faculty, along with postdoctoral fellows, visiting scholars, graduate and undergraduate students, have collaborations and joint programs with scientists in over 15 countries. We take great pride in teaching our undergraduate and graduate students, and have developed an instructional Physics website (Hyperphysics) which receives about 50 million hits per year! The Department also runs the CHARA Array, the largest optical/IR interferometer in the world. We offer graduate programs of study leading to the MS degree in physics and the PhD in physics or in astronomy. The Department's goal of excellence in graduate education is promoted by: an emphasis on meaningful research beginning the student's first semester, individualized attention, a curriculum providing a solid foundation in physics and astronomy as well as diversity for individual interests, active participation by students at major accelerators and telescopes at national laboratories and observatories, access to powerful computing and image processing facilities, well-equipped experimental research laboratories, particular attention to skill training to enhance the students' employment prospects, and close working relationships with scientists actively engaged in research.

LIGO (Laser Interferometer Gravitational-wave Observatory)

Booth Number: 10
Contact: Lynn Cominsky, lynnc@universe.sonoma.edu
Website: www.ligo.caltech.edu

With the first direct detection of gravitational waves on September 14, 2015, the Laser Interferometer Gravitational-wave Observatory (LIGO) has opened the field of gravitational-wave astrophysics. Gravitational waves are ripples in spacetime, and were predicted by Einstein's General Theory of Relativity a century ago. LIGO consists of two widely separated interferometers within the United States—one in Hanford, Washington, and the other in Livingston, Louisiana. LIGO is funded by the National Science Foundation, and is operated by Caltech and MIT. A team of over 1000 scientists world-wide participate in LIGO's Scientific Collaboration.

Michigan State University

Booth Number: 11
Contact: Zack Constan, constan@nscl.msu.edu, 517-908-7363
Website: www.pa.msu.edu

Michigan State University's Department of Physics and Astronomy offers graduate programs leading to Masters and Ph.D. degrees in both physics and astrophysics. Our greater than 65 faculty and 175 graduate students are pursuing research programs which include experimental and theoretical work in the general fields of accelerator physics, acoustics, atomic, molecular and optical physics, biological physics, computational physics, condensed matter physics, elementary particles, low-temperature physics, nanoscience, nuclear physics, physics education, and quantum computing. Students pursuing a doctoral degree in the Department may elect joint programs with many partnering departments including Biochemistry, Chemical Engineering, Chemistry, Computational Mathematics Science and Engineering, Electrical and Computer Engineering, Materials Science, and Mathematics.

Old Dominion University, Department of Physics

Booth Number: 12
Contact: Charles Sukenik, lokun@odu.edu, 757-683-6086
Website: www.odu.edu/physics

Old Dominion University (ODU) is a state-supported university located in Norfolk, Virginia, at the mouth of the Chesapeake Bay, and is classified as a Carnegie Research Institution with "high research activity." The

ODU Physics Department (www.odu.edu/physics) has 22 regular faculty members, 50 graduate students and over 90 physics majors and minors. Research areas include experimental and theoretical nuclear physics, experimental and theoretical atomic and few-body physics, accelerator science, condensed matter physics, geophysics and material science. The Department maintains close ties with nearby Jefferson Lab and the NASA Langley Research Center.

Oregon State Physics Department

Booth Number: 13
Contact: Kelby T. Peterson, petekelb@oregonstate.edu
Website: physics.oregonstate.edu

Oregon State Physics emphasizes condensed matter and biophysics with a strong emphasis on optics. In addition we have a nationally recognized Physics Education research group and small groups in astrophysics and elementary particles. Our courses for majors are very interactive and all majors are involved in research so undergraduates as well as graduate students are very involved in the life of the Department.

San José State University, Department of Physics and Astronomy

Booth Number: 14
Contact: Michael Kaufman, Michael.Kaufman@sjsu.edu
Website: physics.sjsu.edu

The SJSU Department of Physics & Astronomy offers Bachelor's (BS, BA and BA - Preparation for Teaching) and Master's degrees (with optional concentrations in Computational Physics and Modern Optics). The Department prepares students for careers in the high-tech sector of the vibrant Silicon Valley and beyond, while also providing a solid foundation to pursue graduate work in Physics, Astronomy, Engineering, or other areas of physical sciences. Our faculty specialize in computational physics, optics, astrophysics, physics education research, condensed matter physics, and quantum foundations. Graduate and undergraduate students work with faculty on cutting edge-research, making discoveries from the smallest superconductors to the densest galaxies and everything in between. Visit us at www.physics.sjsu.edu to learn more.

STAR – STEM Teacher and Researcher Program

Booth Number: 15
Contact: Shawn Kirby, spkirby@uci.edu, 714-421-8938
Website: www.starteacherresearcher.org

STAR is a 9 week summer program for aspiring STEM teachers from CSU Campuses or the Robert Noyce Scholarship Program. We match applicants with researchers for paid summer Fellowships, weekly education workshops, and conferences. Visit the STAR website to learn more.

The University of Mississippi

Booth Number: 16
Contact: Cecille Labuda, cpembert@olemiss.edu
Website: www.olemiss.edu

The Department of Physics and Astronomy offers Master's and PhD degrees in physics, and all students admitted to our graduate program receive full financial support. We offer exciting research opportunities in atmospheric physics, condensed matter physics, gravity, high energy physics, and physical acoustics. The University of Mississippi carries the R1 Carnegie designation reserved for Doctoral Universities with the highest level of research activity.

University of California, Merced

Booth Number: 17
Contact: Scheibner, Michael, mscheibner@ucmerced.edu, 209-228-4400
Website: physics.ucmerced.edu

University of California, Santa Cruz

Booth Number: 18
Contact: Katie Hellier, khellier@ucsc.edu
Website: www.ucsc.edu

University of Central Florida

Booth Number: 19
Contact: William Kaden, wiliam.kaden@ucf.edu
Website: www.ucf.edu

University of Nevada, Las Vegas, High Pressure Science & Engineering Center

Booth Number: 20
Contact: Pamela Burnley, burnley@physics.univ.edu, 702-895-5460
Website: hipsec.unlv.edu

The High Pressure Science and Engineering Center (HiPSEC) is a multi-disciplinary research group consisting of faculty, staff and students in the

Physics and Astronomy, Geoscience, Chemistry and Engineering Departments at UNLV. HiPSEC offers interdisciplinary graduate studies in topics of interest to the Department of Energy's Stockpile Stewardship program and focuses on placing its graduates in positions at the nation's National Laboratories. HiPSEC students investigate the effects of pressure on matter using a suite of experimental techniques including diamond anvil cell, shock wave and large volume apparatus studies, synchrotron x-ray diffraction and laser spectroscopy, as well as theoretical and computational approaches. HiPSEC is a member of High Pressure Collaborative Access Team (HPCAT) at the Advanced Photon Source, Argonne National Laboratory and enjoys extensive access to HPCAT's synchrotron beamlines.

University of Notre Dame, Department of Physics

Booth Number: 21
Contact: Kenjiro Gomes, kgomes@nd.edu
Website: physics.nd.edu

University of Notre Dame, Department of Physics seeks to provide an outstanding and distinctive education to our undergraduate and graduate students, while also maintaining a broad, vibrant research program as we attempt to answer some of the most fundamental questions in nature. The Department does research in a number of exciting areas including Atomic, Astrophysics, Biophysics, Condensed Matter, Network, Nuclear and High Energy Physics.

University of Virginia, Physics Department

Booth Number: 22
Contact: Steven Stetzler, sgs7cr@virginia.edu, 610-507-5051
Website: phys.virginia.edu

University of Virginia students will be available to answer questions about the UVA Physics department. We will be handing out brochures describing our graduate program. We will also be giving out UVA Physics related swag upon the successful completion of a Physics challenge.

Virginia Tech, Department of Physics

Booth Number: 23
Contact: Betty Wilkins, bewilki2@vt.edu
Website: www.phys.vt.edu

The Department of Physics at Virginia Tech, located in beautiful southwest Virginia, offers both Master's and Ph.D. degrees in Physics. The department is comprised of 31 full-time faculty members, 86 graduate students, and about 400 undergraduate physics majors. Research areas include: astrophysics, biophysics, condensed matter experimental and theoretical, particle experimental and theoretical, and string theory. We are currently accepting applications for Fall 2017 through January 5th, so please stop by our booth to learn more about the graduate education opportunities that await you at Virginia Tech!.

Washington University, St. Louis, Department of Physics

Booth Number: 24
Contact: Alexander Seidel, seidel@wustl.edu, 314-935-8933
Website: physics.wustl.edu

Washington University in St. Louis is a private research university in suburban St. Louis, MO, with a long standing tradition in physics research excellence. Our faculty are world leaders in their fields of research, with active groups working in astrophysics and space sciences, condensed matter and materials physics, particle and nuclear physics, and applications of physics to biology and medicine. Our graduate program offers incoming students generous support for their first two years, and a friendly community in which to pursue their research aspirations. As a physics department, we are committed to the promotion of diversity within the culture of scientific inquiry. We especially encourage the application of women and under-represented minorities to our graduate and undergraduate programs.

Western Michigan University

Booth Number: 25
Contact: Paul Pancella, paul.pancella@wmich.edu
Website: wmich.edu

Newport Corporation

Booth Number: 101
Contact: Hung Hoang, hung.hoang@newport.com, 949-863-3144
Website: www.newport.com

At Newport we believe that the best way to enhance life and fuel discovery is to support experts, by being experts. As a global company, we draw upon expertise from around the world to provide knowledge and solutions from our family of brands that includes; Corion® Filters, New Focus™, Oriel® Instruments, Richardson Gratings™ and Spectra-Physics® Lasers. One company and brands you trust for world-class photonics.

Optical Society of America

Booth Number: 102
Contact: Curtis Burrill, cburrill@osa.org, 202-416-1915
Website: www.osa.org

OSA celebrates its 100th anniversary in 2016, marking a century of innovation. As part of our celebration, we have created a Centennial Exhibit that highlights 100 iconic images representing OSA and the world of optics and photonics. Come check us out while you are at PhysCon 2016!

American Physical Society

Booth Number: 103
Contact: Courtney Bougher, bougher@aps.org, 301-209-3271
Website: www.aps.org

The American Physical Society is the professional society for physicists. With over 50,000 members APS works to advance and disseminate the knowledge of physics worldwide. Through meetings, journals and other publications APS delivers the latest physics information and works to create a stronger physics community. In addition to its services for members, APS provides career information for those interested in pursuing all types of physics as a career path. Using websites, webinars, and profiles APS shows students the endless possibilities a physics degree can bring. APS has a commitment to exciting and inspiring the general public. Through its outreach website, www.physicscentral.com, the PhysicsQuest middle school program, a series of physics-centric comic books and many other programs APS brings the joy of physics to all.

SPS & ΣΠΣ Store

Booth Number: 104
Contacts: Sacha Durham-Purnell, spurnell@aip.org, 301-209-3007
Lydia Quijada, lquijada@aip.org
Website: www.spsnational.org

Show your physics pride! Stop by the Society of Physics Students (SPS) and Sigma Pi Sigma (ΣΠΣ) store for PhysCon, SPS and Sigma Pi Sigma branded gear.

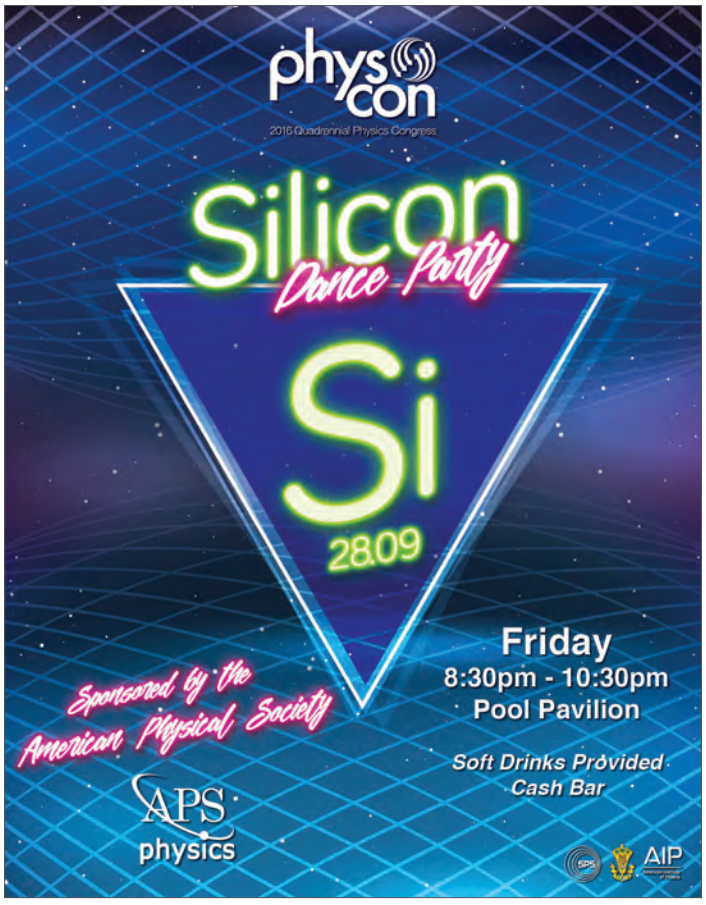
American Institute of Physics

Booth Number: 104
Contacts: Liz Dart Caron, lcaron@aip.org, 301-209-3034
Philip Hammer, hammer@aip.org, 301-209-3142
Website: www.aip.org

The activities and staffing of the Society of Physics Students (SPS) and Sigma Pi Sigma are both supported by the American Institute of Physics (AIP). Stop by to explore the programs, awards, benefits, and services provided with your SPS and Sigma Pi Sigma memberships. AIP also sponsors other programs that are valuable to undergraduates, including the Careers Toolbox, SPS Jobs site, GradSchoolShopper.com and *Physics Today* magazine—come by the booth to spin the prize wheel and learn more.

Stop by the PhysCon Store and Grab Some Merch!

Sigma Pi Sigma Honor Stole	$42
Sigma Pi Sigma Honor Cord	$15
Sigma Pi Sigma Tassel	$12
Sigma Pi Sigma Lapel Pin	$8
SPS/Sigma Pi Sigma Polo shirts	$25
SPS/Sigma Pi Sigma Executive Padfolio	$25
PhysCon T-shirts	$15
PhysCon Toothpick Holders (shot glass)	$5
SPS Water Bottles	$10
SPS Bottle Opener	$4
"Physics is Good for You" Slinky	$3
"Physics is Good for You" Iron-on Patch	$4



The Careers Toolbox is a new online resource specifically created for physics undergraduates. It's available free at

www.spsnational.org/careerstoolbox

The Careers Toolbox:

- Includes worksheets and real-life exercises that make physics undergrads more effective job seekers
- Helps users translate their physics undergraduate experience into skills that hiring managers understand and value
- Enables undergrads to assess the suitability of different career paths for their skills and interests
- Shares research data about the career trends, common job titles, and starting salaries of physics graduates

Careers Toolbox

for Undergraduate Physics Students

UNIVERSITY OF OREGON

Earn a Master's Degree AND a Paycheck.

The Industrial Internship Program at the University of Oregon

Industrial Partners:

Photovoltaic & Semiconductor Device Processing

AGC Electronics America, Applied Materials, Brewer Science, CAMCOR, Cascade Microtech, ESI, FEI, GLOBALFOUNDRIES, Hewlett Packard, Hitachi, Los Alamos National Lab, Microchip Technology, Mobile Semiconductor, Moxtek, Nanohmics, nLight, Polaris Battery Labs, Qorvo, Quantum Innovations, Raytheon, Sharp Labs of America, SolarWorld, SupraSensor Technologies, TSI Semiconductors, Voxtel.

Optical Materials & Devices

Arete´ Associates, Brewer Science, CAMCOR, Cascade Microtech, DigiLens, ESI, Fiberguide, GLOBALFOUNDRIES, Lockheed Martin, Metrue, Moxtek, Nanometrics, nLight, Northop Grumman, Orb Optronix, Quantum Innovations, Raytheon, Spectra-Physics, Thermo Fisher Scientific, Thorlabs, Timbercon, Voxtel, Zayo Group, Zemax.

What is it?

A master's program in applied physics featuring concentrated classroom and laboratory instruction with a 9-month paid internship in industry.

What Makes It Special?

You can earn between $3,000 and $5,400 per month during the internship.

Approximately 90% of interns receive regular job offers.

The majority of our students finish in just over a year.

Academic Requirements?

A bachelor's degree in one of the following:

Physics, Chemical or Electrical Engineering, or related field.

And a desire to start your career!

internship.uoregon.edu