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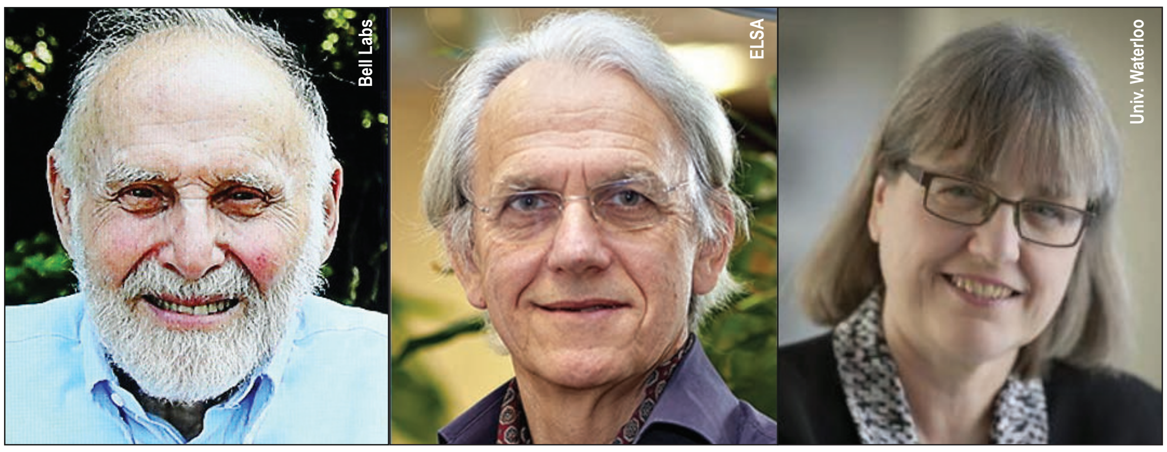
The 2018 Nobel Prize in Physics



L-R: Arthur Ashkin, Gérard Mourou, Donna Strickland

By Leah Poffenberger

On October 2, the Royal Swedish Academy of Sciences announced this year's winners of the Nobel Prize in Physics. Recipients of the 2018 prize, awarded "for ground breaking inventions in the field of laser physics," are: Arthur Ashkin (formerly at Bell Laboratories), Gérard Mourou (École Polytechnique, France, and the University of Michigan, Ann Arbor, United States), and Donna Strickland (University of Waterloo, Canada). Strickland is the third female physicist to receive this award and the first to do so since 1963.

Half of the Prize goes to Ashkin for "optical tweezers," a device for grabbing and manipulating small objects, and its application to biological systems. This work was first published in *Physical Review Letters* (PRL). The other half was jointly awarded to Mourou and Strickland for their method of generating high-intensity, ultra-short optical pulses. Both inventions represent major breakthroughs in the use of laser beams for practical purposes.

"Art Ashkin's beautiful experiments at Bell Labs inspired his fellow physicists to pursue laser cooling and optical traps, which in turn has led to degenerate quantum gas physics, laser tweezers for bio-

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For Member Comment: Proposed APS Ethics Statement

Over the past year, a subcommittee of the APS Panel on Public Affairs has been reviewing, updating, and combining the existing APS statements in the areas of ethics and professional conduct into one comprehensive document that addresses expected standards of behavior and professional activity.

A draft of this revised Statement on Ethics is now available and has been approved by the APS Board of Directors to be sent to APS members for comment. Your comments are welcomed and suggestions for improving the statement are encouraged.

All comments will be read and will receive full consideration by the Panel on Public Affairs subcommittee as it prepares a final statement that will be forwarded to the APS Council for approval early next year.

Please review and submit any comments on the draft statement webpage no later than November 26, 2018.

Ethics Statement webpage:**go.aps.org/stmtethics**

Winners of 2018 Apker Award Announced

By Leah Poffenberger

This summer, six finalists for the 2018 APS LeRoy Apker Award traveled to Washington DC to present their undergraduate research to a panel of judges (*APS News*, August/September 2018). Now, the winners of the prestigious award have been announced. This year's award recipients are: Nicholas Sherman (University of California, Davis) and Eric Cooper (Pomona College).

Nicholas Sherman

Eric Cooper

Every year, two awards are presented, one to a student from a PhD granting institution, and one to a student from a non-PhD granting institution. The award is accompanied by a $5,000 prize for each winner and another $5,000 for each of their physics departments. Sherman and Cooper will also both receive funds to travel to Boston for the 2019 March Meeting and present their research in an invited session. Thanks to the Apker selection meeting, they've both already gained valuable experience impressing a crowd of physicists.

In August, Sherman and Cooper went before the Apker selection committee, made up of physicists from a variety of backgrounds, for assessments of their research, their presentations, and their ability to field a barrage of questions.

"The questions were the hardest to prepare for—you can prepare for the talk, but you can't predict what you'll be asked," says Sherman. His advice to future presenters: investigate how their

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PHYSICAL REVIEW FLUIDS

Go With the Flow

By Gary Leal, John Kim, and Bradley Rubin

Physical Review Fluids (PRFluids) is one of the newest members of the APS journal family that grew out of the original *Physical Review*, which this year is celebrating its 125th anniversary. Following its first issue in May 2016, PRFluids has now published more than 1,000 high-quality peer reviewed papers—including more than 100 Rapid Communications, the shorter letter-style papers of special significance. PRFluids welcomes submissions in experimental, theoretical, and numerical research, from fundamental fluid physics of a wide variety of flows, to fluid mechanics with applications related to energy creation and harvesting, through biology, forensic science, and climate change.

The journal has made a great start and is firmly on track to becoming the fluid dynamics journal of choice. In achieving this, the journal has benefited greatly from the support of and collaboration with the APS Division of Fluid Dynamics (DFD), including the publication of the invited and prize lectures from the annual meeting, as well as the Gallery of Fluid Motion based upon the winning poster and video entries each year. In addition, the François Frenkiel Award of the DFD is awarded each year for the best paper by authors under the age of 40 published in PRFluids.

Although PRFluids is a relatively new journal, its roots date back more than 70 years. DFD has had a long tradition of close association with a journal in fluid dynamics. For many years the main venue for disseminating the work of DFD members was the journal *Physics of Fluids*, which is published by the American Institute of Physics Publishing. Indeed, the DFD was instrumental in founding *Physics of Fluids* in the first place.

The Physical Review, from the beginning, had included fluid mechanics in its coverage of physics, and especially since 1993, in a more broadly based APS journal, *Physical Review E*. However, in 2015 the DFD decided that it could better serve its members as well as the global readership by having a close association with a dedicated fluid mechanics journal published by APS. In support of the desire of the DFD, the entire editorial staff and the advisory board from *Physics of Fluids* moved to PRFluids in 2016.

125 YEARS

PRFluids is relatively unique within the APS family of journals in that the Lead Editors and Associate Editors are located at universities and research institutions and are active research scientists. The Associate Editors in particular are among the most distinguished individuals in their fields, and they are chosen so that there is broad representation for nearly all of the subtopics within the field of fluid dynamics. The editors are complemented by a very strong Editorial Board, broadly representative in terms of both research expertise and geographic location, with current members based in ten countries. Our authors and referees are also broadly distributed; about half of recently published papers are from outside the United States.

PRFluids strongly encourages the submission of fundamentally oriented theoretical or experi-

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Leon Lederman 1922-2018

By Daniel Garisto

Leon Lederman

Leon Lederman, an experimental particle physicist, director emeritus of Fermi National Accelerator Laboratory, and founder of the Illinois Mathematics and Science Academy (IMSA), died in Rexburg, Idaho on October 3. He was 96.

A recipient of numerous accolades, including the Nobel Prize in Physics as well as the National Medal of Science, Lederman led teams that discovered two elementary particles: the bottom quark and the muon neutrino. He was a Fellow of the APS.

"Leon Lederman embraced science broadly and deeply," said 2018 APS President Roger Falcone. "He uncovered new physics, was a leader in educating students and the public, was a spokesperson for pushing the frontiers of physics, and guided major scientific institutions. His engagement, passion, and enthusiasm remain an inspiration to everyone who knew him."

Lederman could have measured out his life in quips. His "unauthorized autobiography" states that "Leon Lederman is one of the oldest, barely active particle physicists seen at Fermilab. He began his career back in 1946 when delivering a telegram to someone in the Pupin Physics building of Columbia University; he got lost in the labyrinth of tunnels and emerged four years later with a Ph.D."

"He was very much a stand-up comedian," said Nigel Lockyer, director of Fermilab. "When he got the Nobel Prize, we all poured into the auditorium … and spent the whole time killing ourselves laughing at his jokes."

Science and comedy were not separate preoccupations for Lederman—they were inextricable. Science wasn't meant to be kept in a stuffy lab; it was fun, and therefore meant to be shared with others. To that end, Lederman started Saturday Morning Physics in 1980, which has managed to trick thousands of impressionable young minds into learning physics instead of watching cartoons. Five years later, he founded IMSA, now one of the top public schools in the country.

Former students expressed their gratitude toward Lederman on Tuesday:

"[IMSA] sparked my passion for science, which is still burning a decade after I entered her doors. Thank you, Dr. Lederman. <3"

Leon Max Lederman was born in New York City on July 15, 1922, to Minna and Morris Lederman. He graduated from the City College of New York in 1943 and enlisted in the Army, serving in France and Germany. Back in the States, Lederman learned to love physics at Columbia University, where he eventually became a professor and made prolific discoveries.

In 1956, he discovered the neutral K meson, which proved that charge is conserved in weak interactions. The next year, inspired by promising results from his colleague, C. S. Wu, he performed his own experiment to observe parity violation, in typical Lederman fashion—by appropriating a graduate student's experiment.

"It was 6 p.m. on a Friday, and without explanation, we took the student's experiment apart," Lederman said. "He started crying, as he should have."

Trying to violate parity in a weekend meant "overlooking niceties": a coffee can, wooden cutting board, orange juice bottle, and a can of Coca-Cola were all used as part of the apparatus, which was held together by Scotch tape.

In 1962, with Jack Steinberger and Melvin Schwartz, Lederman discovered the muon neutrino, for which the trio would share the 1988 Nobel Prize in Physics.

But Lederman wasn't always successful. In 1976, at Fermilab, he and his team thought they'd discovered a new particle with a mass of 6 GeV, publishing their results in *Physical Review Letters*. It turned out there wasn't a particle there, so

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This Month in Physics History

November 9, 1825: Public Demonstration of the Limelight

For centuries, stage lighting in the Western world was notoriously primitive, until gas lighting made its debut in the early 19th century and revolutionized the theater. But it was the invention of the limelight a decade later by Sir Goldsworthy Gurney, the quintessential 19th century gentleman scientist, that dominated stage lighting for the next several decades. Although long since replaced by incandescent and LED electric lighting, the invention lives on when we say someone is "in the limelight."

Sir Goldsworthy Gurney

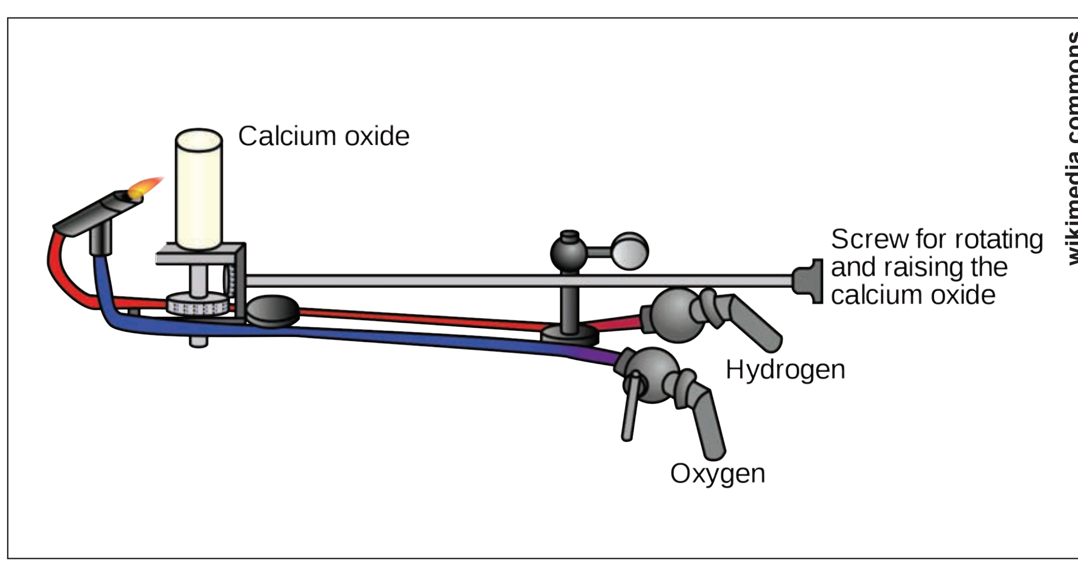
Born in Cornwall in 1793 to a reasonably well-off family, Gurney showed an early interest in science in his education, notably chemistry and mechanical science, even constructing his own piano. He was particularly impressed with a demonstration he witnessed of inventor Richard Trevithick's steam road carriage, dubbed the "Puffing Devil." But initially he trained as a surgeon, starting his own medical practice in 1813 and marrying a local farmer's daughter the following year.

Seven years later the family relocated to London. Gurney still made his living as a surgeon, but the city also introduced him to the broader scientific community. He became a lecturer at the Surrey Institution, teaching chemistry, and invented a device capable of creating an intensely hot flame by combining burning jets of oxygen and hydrogen. The latter provided the technological underpinning for the new kind of lighting that would come to be known as limelight. By trial and error, Gurney figured out that he could produce a brilliant light—bright enough to be visible nearly 100 miles away—by playing a flame on a chunk of lime.

Historical records show that the earliest known use of limelight at a public performance occurred on October 3, 1836, when it was used to illuminate a magician's juggling performance in Kent. A contemporary leaflet used the word "koniaphostic" derived from Greek, describing the effect as bathing "the whole pier with a flood of beautiful white light." Covent Garden Theater used limelight the following year to illuminate its indoor stage, and by the 1860s and 1870s, limelight was commonly used in theaters around the world, and introduced the spotlight to the theater.

Building on his successful invention of limelight, Gurney was able to produce even brighter white light by adding oxygen directly to the flame of an oil lamp. He even figured out how to light his entire house this way via an intricate system of prisms and lenses running through the hallways. He patented the invention in 1839. The British House of Commons purportedly replaced the 280 candles it traditionally used for illumination with three of Gurney's tricked-out Bude lights (named after his town in Cornwall), which remained in place for some 60 years. It wasn't until the invention of arc lighting at the end of the 19th century that limelight

LIMELIGHT continued on page 7



Gurney's "limelight" directed an oxygen-hydrogen flame at a piece of calcium oxide, creating a bright white light.

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Education and Diversity Update

Looking for ways to improve your physics teacher education program? Emulate the best!

The PhysTEC program will be hosting a webinar to support physics departments in improving their teacher education programs. The webinar will show how to complete the new Physics Teacher Education Program Analysis (PTEPA) Rubric at phystec.org/thriving/. The PTEPA Rubric is a self-assessment instrument based on a study of "thriving" programs that routinely prepare at least five physics teachers per year and is designed to help departments analyze and improve their programs. During the one-hour webinar, the lead author of the study, Stephanie Chasteen, will introduce the Rubric, guide participants through one section of it, and answer your questions. The webinar will take place **Tuesday, November 13, at 2:00pm ET**. No signup is needed; just go online to go.aps.org/2yA6sWA at that time.

Professional Skills Development Workshop

The APS, with NSF grant funding, will provide a workshop for senior women in physics with the goal of providing a framework and tools to be agents of change within their professional circles.

In today's world, change is a given, whether in the workplace, the lab, at school, or within APS. Most people experience some level of stress or discomfort when confronting the disruptions change can bring. Whether it is a change in priorities, budgets, direction of a project, or new team members, understanding how we react to change and how to lead others through change is critical to your professional success.

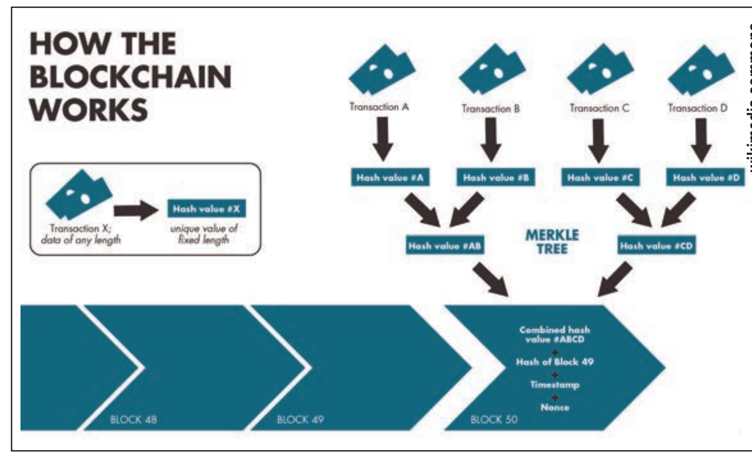
Senior women interested in learning a step-wise process to more effectively lead change initiatives in their institutions and organizations should submit an application by **November 11, 2018**. Nominations will also be accepted. The form to apply or nominate someone can be found at go.aps.org/2yGvseT. Space is limited and all expenses for participation in this workshop will be covered by a grant from the NSF.

Travel Support for Minority-Serving Institutions to 2019 PhysTEC Conference

We are committed to supporting minority-serving institutions that wish to become leaders in physics teacher preparation and are offering a limited number of stipends of up to $1000 to qualified institutions to support travel to the conference. Applications are now open. More information can be found at go.aps.org/2yMXLsj.

Astronomers Tackle Big Data with Blockchain

By Sophia Chen



In a blockchain, fixed-length "hash" values are created from transaction data with a cryptographic algorithm. Each transaction's hash is combined in a "Merkle tree" to form a hash value for a block of transactions (A, B, C, D). When further combined with the previous block's hash and a timestamp, the growing chain is an open but secure ledger: Any retroactive change to a block would require changing all the subsequent blocks.

In 1999, researchers at the University of California, Berkeley, launched SETI@Home, a project that any curious person with an Internet connection could participate in. The scientists designed a program that people could download onto their home computers. When the machines were idle, the program would analyze radio telescope data for signs of extraterrestrial life. Since then, more than 4 million people have lent their computers to search for signs of aliens.

Taking a page from SETI@Home nearly two decades later, Josh Peek is testing a new method to pool home computing power to analyze Hubble Space Telescope images. Peek, a researcher at the Space Telescope Science Institute in Baltimore, Maryland, wants to use a network of computers to classify terabytes of images depicting dark expanses and sparse extraterrestrial structure. "As you look deeper and deeper, there are lots of diffuse structures in the sky that are very complex," says Peek. He wants these computers to implement machine learning algorithms to identify the structures in the images. But his 2018 methods have a twist. To deploy his fleet of home computers, Peek has enlisted a new technology: the blockchain.

Blockchain technology, first invented in 2008 by a pseudonymous person known as Satoshi Nakamoto, is essentially a public spreadsheet for recording digital group activity. By design, no one can modify entries in the spreadsheet after they are written. It works like this: Each entry is linked to two numbers, one known as a hash that is calculated from that entry's value, and the previous entry's hash. This creates a self-referencing chain. If you try to tamper with an entry, all subsequent entries would point to a wrong hash.

In theory, this format creates a permanent, self-regulating record that does not require centralized control. The technology is best known for its role in cryptocurrencies, where it allows people to securely exchange money anonymously without banks. Many blockchain proponents say that it could distribute the power currently held by financial institutions and large corporations such as Amazon that monetize consumers' personal information.

But Peek's blockchain ambitions don't involve world economic reform. "I don't have any interest in changing how finance works," he says. "It's not something I know anything about." He actually just wants to analyze his data—and blockchain may offer an efficient solution.

Although best known in finance, the blockchain doesn't fundamentally involve money at all. The technology, it turns out, can help coordinate computing tasks across thousands or more computers. It's a tool that allows multiple computers to work collectively in a decentralized way. The computers in Peek's decentralized network collectively run machine learning algorithms to distinguish stars, galaxies, and other exotic blobs from each other. Each machine in the network takes a little chunk of the problem, analyzing a piece of an image at a time. And unlike SETI@Home, which used volunteers, Peek plans to use the blockchain to pay everyone who helps him process the images.

To execute this blockchain-facilitated pipeline, Peek collaborated with Bay Area-based blockchain startups Aikon and Hadron earlier this year. The idea was born from a conversation Peek had with Aikon's chief product officer, Marc Blinder, who is a childhood friend. "Josh is always looking for new ways to use new technology in astronomy," says Blinder. The two found another collaborator in Cliff Szu, the CEO of Hadron, which specializes in deploying machine learning algorithms on distributed networks.

They have yet to deploy their analysis pipeline at full capacity, but the plan is for it to essentially work like this: Hadron, collaborating with Peek, has developed a machine learning model that classifies astronomical objects in Peek's

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the data blip was named the Oops-Leon. (The next year, they discovered the actual Upsilon particle.)

Lederman moved to Fermilab in 1979, where, as director for the next decade, he delighted scientists and visitors alike with his leadership and scintillating personality. Under his watch, Fermilab constructed the Tevatron, then the most powerful particle accelerator in the world.

In his later years, he moved to Idaho with his wife Ellen Carr Lederman, who survives him. She took care of him after he was diagnosed with dementia. In 2015, he sold his Nobel prize to raise money for medical funds.

Lederman was also infamous for the name that he came up with the popularize the Higgs boson, calling it the "God Particle," which was also the title of one of his more than half-dozen books. Beneath the flashy title were witty anecdotes, cogent explanations of science, and wisdom.

"Scientists, more often than not, are people," he wrote. "We count among us minds of awesome power, those who are only monstrously clever, those possessed of magic hands, uncanny intuition, and that most vital of all scientific attributes: luck."

The author is a freelance science writer based in New York.

Profiles in Versatility

"Failed" Physicist? From biologist turned Nobel Laureate to author.

By Alaina G. Levine

Venkataraman Ramakrishnan started as a physicist. Then he became a biologist. Then he helped elucidate the structures and functions of the ribosome, the biomolecule that turns genetic code into protein, for which he won the 2009 Nobel Prize in Chemistry. Now he's an author too, and his book is *The Gene Machine: The Race to Decipher the Secrets of the Ribosome* (Basic Books, 2018).

Ramakrishnan did his PhD in theoretical physics but along the way, biology began to entice him and he realized this was his calling. He went back to grad school in life sciences—a humbling encounter, as few universities were interested in taking someone who already had a doctorate. It was frustrating at first because he didn't know the terms, was unfamiliar with lab work, and had to take undergrad courses to catch up. But as he once told a group of young scientists, "You have to be willing to go backwards and start from the beginning. You have to have humility."

Ramakrishnan, who today is a senior scientist at the MRC Laboratory of Molecular Biology in Cambridge, UK and the president of the Royal Society, is a passionate advocate for science and science communication.

As I was explaining the nature of this article and the Profiles in Versatility column, concerning physicists in unusual career paths, he interrupted me, and shared his first gem of the day. "Most people would not call me a physicist," he said. "You could think of me as a failed physicist if you like." I couldn't let that go, so our interview immediately commenced.

AGL: Do you consider yourself a failed physicist?

VR: It's a little difficult to say because I was not interested in the problems I was working on. I didn't have a good sense of what to do in physics. I felt if I stayed on, I would have done some very boring calculations that didn't actually amount to anything. That was the negative part. Of course, the positive part was that I found modern molecular biology extremely interesting, so I went into it.

Venkataraman Ramakrishna

AGL: What was it that drew you to physics in the first place?

VR: I was attracted by the beauty, elegance, and ability to take complex phenomena and find the underlying unity in them. I think physics is very beautiful intellectually.

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Scientific Research Stimulates Kansas Economy

By Kristan Corwin

Kristan Corwin

I feel very fortunate to have a career in science, working as a physicist in Kansas.

Many people helped make it possible: My father taught me hands-on problem solving through simple woodworking. My chemistry teacher taught me to marvel at the structure of a single atom, and my college professors helped me reveal its secrets.

Building Kansas' scientific and technical workforce requires opportunities and support for more students to build on those formative moments.

Science, technology, engineering and mathematics (STEM) jobs pay on average $75,000 per year in Kansas. And according to one prominent Kansas company, says Carly Hysell, Garmin's public relations manager: "We need a steady supply of very talented engineers and information technology professionals. Our best source of talent is right here in our backyard."

In graduate school, as an apprentice to a master scientist, I learned to discover things about atoms that no one knew before. My fellow students and I did research funded by the National Science Foundation (NSF), the National Institute of Standards and Technology (NIST), and other federal agencies. My former classmates are now leaders in industry, universities and government laboratories, tackling the technical problems of our time.

Like me, many are training the next generation of scientists and engineers.

Training our students for careers in STEM is a win-win for Kansas — it gives our students opportunities and also enables us to carry out research that benefits our state.

As a physicist at Kansas State University, I develop tools that may improve agricultural yields. The project uses lasers to measure the gases above fields of crops, helping

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research relates to other fields of physics for a mixed-background audience. Sherman detailed his work modeling the dynamics of anyons—weird quasiparticles that might be harnessed to do quantum computations—that served as the subject of his senior thesis.

Cooper, also a recent graduate with a degree in physics, demonstrated the results of his research on the aerodynamics of exploding seed pods, showing how physical concepts impact the biological world.

"This was the longest talk I've given, and I learned a lot about the process of presenting detailed research," says Cooper. "It was interesting to present in front of judges and learn how to be convincing. They asked a lot of questions to make sure I understood the research and that they did as well."

Sherman and Cooper are continuing their physics careers, now at graduate school: Sherman is attending the University of California, Berkeley, and Cooper is a student at Stanford University. Sherman expects to continue in condensed matter theory, and Cooper has transitioned into atomic and molecular physics.

For more on the Apker Award visit aps.org/programs/honors/prizes/apker.cfm

The APS Office of Government Affairs

APS Members Attend State Meetings to Support F-1 Visa Dual Intent Provision

By Tawanda Johnson

APS members have been meeting with congressional staffers in seven states to urge Congress to allow F-1 student visa applicants to express "dual intent,"—enabling international students to apply for permanent legal status in the US while they are students (see *APS News*, October 2018).

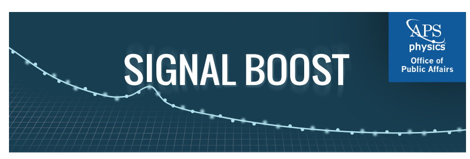
About 10 APS members have attended meetings in Alaska, New Hampshire, Illinois, Kansas, Vermont, New York, and West Virginia.

"The meetings have been going really well in the states, and APS leadership has been having meetings with congressional staffers in Washington, DC to reinforce the strategy on the federal level," said Greg Mack, grassroots advocacy manager in the APS Office of Government Affairs (OGA). APS OGA provided the APS member volunteers with information, materials, and coaching, and arranged the meetings with the congressional offices in the states. This in-state approach allows for more constituents to be able to tell their compelling personal stories to the offices.

Historically, the United States has had an unrivaled ability to attract the best and brightest students from around the world. Complementing the nation's home-grown STEM talent, international students help provide the US innovation ecosystem with the next generation of scientists and engineers necessary for America to remain a global leader. But the 21st-century landscape is changing—international applications and enrollments to US-based STEM programs are declining. The National Science Board's *Science and Engineering Indicators 2018* showed a 6% decline from 2016 to 2017 in the total number of international graduate students at US institutions across all STEM fields.

Read more about the F-1 visa issue at go.aps.org/2Ockpz1.

The author is APS Press Secretary.



Signal Boost is a monthly email video newsletter alerting APS members to policy issues and identifying opportunities to get involved. Past issues are available at go.aps.org/2nr298D. To receive Signal Boost and learn more about grassroots activities, contact Greg Mack at mack@aps.org.

Join Our Mailing List: visit the sign-up page at go.aps.org/2nqGtJP.

FYI: Science Policy News From AIP

Efforts to Address Sexual Harassment in Science Gain Momentum

By Alexis Wolfe

With the research community and Congress calling strongly for action, some federal agencies and scientific societies have begun to advance new initiatives to combat sexual harassment in science.

The National Science Foundation (NSF) has taken some of the quickest steps, implementing a new policy in October requiring institutions to report any findings of sexual harassment committed by an NSF-funded principal investigator (PI) or co-PI. The policy does not require institutions to report the initiation of investigations into harassment complaints, but it does require them to report certain actions, such as if an accused individual is placed on administrative leave during an investigation.

Based on the information reported, NSF may remove the PI or co-PI from the grant, reduce the funding amount, or, when neither option is appropriate, suspend or terminate the grant.

"This new policy is intended to provide targeted, serious consequences for harassers. It gives people tools to make harassment stop without disturbing others' careers and lives," said NSF Director France Córdova in a statement on the new policy.

The National Institutes of Health (NIH) also announced initiatives to address sexual harassment, which include establishing a centralized process for managing harassment reports for its intramural research program as well as launching a website that details its policies and efforts to address misconduct.

NIH has been criticized for not taking stronger actions, particularly for its extramural grant programs.

Following the release of NSF's new policy, NIH Director Francis Collins said that certain "legal constraints" prevent the agency from implementing similar reporting requirements without undergoing a formal rulemaking process. Currently, NIH-funded institutions must report if grantees are placed on administrative leave or removed from their position, but they are not required to report findings of harassment.

Meanwhile, there are increasing calls for the government to take more comprehensive action.

Kelvin Droegemeier, the nominee to direct the White House Office of Science and Technology Policy (OSTP), has expressed support for an interagency effort. At his confirmation hearing in August, he said NSF's actions have "put an important stake in the ground," and that OSTP could "promulgate" similar efforts across R&D funding agencies.

In Congress, the House Science Committee has requested a Government Accountability Office (GAO) report on how sexual harassment claims are handled across the government and recommended actions agencies should consider, such as clarifying their ability to replace PIs based on allegations or findings of sexual misconduct.

A number of Democrats on the Science Committee have introduced legislation that would expand NSF support for research on sexual harassment in the scientific workforce and create an interagency working group to coordinate policy responses. The bill has been endorsed by over a dozen scientific societies, including APS.

Scientific societies have also mobilized to address the problem. The American Association for the Advancement of Science recently established procedures for revoking the status of elected fellows in response to breaches of professional ethics, including sexual misconduct and harassment.

Some societies, such as the American Geophysical Union and American Astronomical Society, have already implemented policies to combat harassment by their members. Many others are preparing their own response. For instance, APS is in the process of updating its ethics statement (go.aps.org/stmtethics) and is proposing to form a standing committee on ethics that will address sexual harassment, among other topics.

Leaders from dozens of scientific societies, including APS, convened in October to discuss sexual harassment, the first time so many societies have gathered to discuss action on the issue. They intend to form a consortium in the coming months that will develop model policies and a resource toolkit that societies can use to help craft their own responses.

The author is a science policy analyst with FYI *at the American Institute of Physics.*

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agronomists better understand the interactions of plant genetics with fertilizer and water.

My federally funded research program has propelled students from Kansas into Ph.D.-level positions as senior scientists in small businesses and government labs, working on laser-based research for private industry and the U.S. government. Having world-class research available to Kansas high school graduates in their home state has given them excellent job opportunities. The hands-on, critical thinking skills they develop open many doors, and empower them to address the most pressing challenges facing our nation in areas such as agriculture, energy, health and national security.

Our project is one example of the unique, forward-looking research funded in Kansas by the National Science Foundation (NSF), which invested $36.7 million in research in the state during the past year. These projects allow the exploration of fundamental scientific ideas that underpin American innovation and train our students for careers in STEM.

NSF research has transformed our lives here in Kansas—from the way we shop, to how we consume information, to how we receive daily weather reports. Specifically, NSF research has generated or improved barcodes, web browsers, fiber optics and Doppler Radar.

Furthermore, NSF pays dividends for the entire nation. Since the end of World War II, economists have determined that more than half of the nation's economic growth can be traced to scientific discoveries, according to a 2014 report by the American Academy of Arts & Sciences.

My science career grew from natural curiosity, nurtured by engaging teachers. My training was made possible by federally funded research projects. Now I lead investigations using physics to improve agriculture, while in turn creating opportunities for Kansas' students.

There are kids all across our state right now with similar desires and aptitudes, ready for a STEM career. Will similar opportunities await them?

Kristan Corwin is chairwoman-elect of the APS Division of Laser Science and professor of physics at Kansas State University. This article first appeared in the Topeka Capital-Journal *newspaper.*

Careers Report

"I Graduated – What Now?"

By Hendrik Ohldag

On July 7, 2018 the APS Far West Section held a career workshop at SLAC National Accelerator Laboratory. After a similar event had attracted a rather large crowd in 2017, the section promised to make it a regular item on their meeting calendar. Career opportunities for physicists have become increasingly diverse and somewhat confusing over the past decade. Although the market for research jobs in academia or national labs has not significantly changed, there has been tremendous growth in opportunities for physics graduates in other sectors, e.g. the areas of data science, health science, general IT and so on. However, from conversations with students we learned that many are not aware of the variety of options and how to pursue them. They felt that an event providing not only some general information but also personal insight into the job market for physicists would be extremely helpful. Based on this feedback from the students, the section invited speakers and panelists to provide exactly this missing link.

Peter Fiske opens the workshop by talking to students and postdocs about "how to put your science to work."

The 2018 meeting was attended by close to 150 students from the region. The day started with a featured a presentation by Peter Fiske (Lawrence Berkeley National Laboratory), entitled "Put Your Science to Work." Peter is a regular contributor to APS career events through his presentations and webinars. These events are crucial because "career development workshops at local and regional levels of APS have two advantages: they can be scheduled at any point during the year, and students don't need to travel as far as the annual meeting to participate," said Fiske. "It's a great way for APS to show how it is concerned for the next generation of physicists."

Fiske pointed out that physics students obtain a unique skill set during their studies that will set them apart from other job applicants. However, being part of the team is as important as standing

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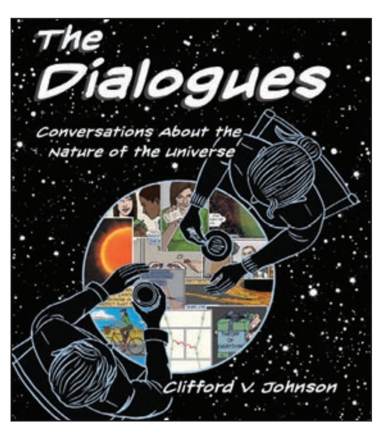
Moving the Story Beyond Alice and Bob



Styles of communication (L-R): Clifford Johnson, Jeffrey and Tanya Bub, and Rebecca Thompson

By Eran Moore Rea

Scientists are increasingly using comics as a way to move readers from bystanders to integrated participants in the dynamic action of physics. Too often, popularizers of science rely on clichés like Alice and Bob, the imaginary characters that physicists use to explain how quantum information is sent and received. But through conversations and stories, the three writers featured below move the stories in popular physics accounts beyond the familiar examples—beyond Alice and Bob arguing over entanglement.

Physicist Clifford Johnson welcomes readers into the unsure, back and forth conversations between physicists. Philosopher Jeffrey Bub gives readers more say in how they experience theoretical physics by placing them into familiar thought experiments. And APS Head of Outreach Rebecca Thompson concentrates on creating a compelling story to draw middle schoolers into the conversations of characters who use physics to solve problems.

Clifford Johnson was looking for something beyond the Standard Model.

The Standard Model of Physics Outreach Books, that is. Johnson, Professor of Physics and Astronomy at the University of Southern California, has been active in outreach at the national level since he began BBC radio broadcasts in the late 1990s. In Johnson's view, there is a format for physics outreach books written by physicists for popular audiences.

Often, it's an 11-chapter book, Johnson said. "Chapter one introduces classical physics, chapter two is a bit of quantum mechanics, chapter three a little bit of relativity. By chapter 10, everything is introduced, and then chapter 11 is what the author really wanted to talk about, what's going on now in the field," Johnson said.

This does not mean that Johnson sees the Standard Model of Physics Explainer Books as a bad thing. After all, in physics, the Standard Model has lasted as long as it has for a reason: it works. The 11-chapter model is an effective and quick way to explain some ideas in physics, and many prose books do it "beautifully," according to Johnson.

But Johnson decided he did not want to write a book explaining physics, per se. Instead, he wanted to write a book of conversations that might happen between physicists or other people in, for example, a café—casual, disjointed, real conversations.

"If it's a real conversation, people are going to say stuff that you don't understand," Johnson said. "Eventually, [it] will make sense in context. In the book, the reader can get a sense of many of the ideas that are discussed in that conversation, without me having to join all the dots, pull [you] by the hand and take you through the whole thing." Johnson's book, a physics comic book entitled *The Dialogues: Conversations about the Nature of the Universe*, was published in October 2017. And

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ALICE & BOB continued from page 5

Johnson's book is not alone; the world of comics written about physics by physicists is growing. Bub and Thompson do write comics that explicitly want to explain science, but they agree with Johnson: the medium and message cannot be separated. Science comics do not work if you think of them as "putting my lecture into mouths of a few different characters," Johnson said.

As Johnson set out dedicating himself to learning to draw (a process that took over six years in his spare time as he realized he wanted to illustrate his comic himself), he realized the multi-faceted potential of illustrations for a popular physics book; not only could he illustrate the geometric nature of physics concepts, he could also reflect a diversity of people having these conversations.

In contemporary physics books—popular or textbook—Johnson sees that any conversation is normally limited to "a few pages of a dialogue between Alice and Bob if they're worrying about a quantum state."

Jeffery Bub was excited to delve into that conversation between Alice and Bob.

A professor of philosophy with a PhD in physics, Bub carries out research at the University of Maryland that probes the foundations of physics. In 2016, he published a book intended for a popular science audience, *Bananaworld*. The book was written so that his son, a physiologist, would find it enjoyable and interesting. But after publication, his son reported that he got lost in the math.

So Bub decided to try a comic that everyone could read.

Totally Random: Why Nobody Understands Quantum Mechanics, published in June 2018, literally puts thought experiments that prove quantum correlations into the hands of the reader. The narrative of the comic takes the reader through the process of discovering two entangled "coins" by drawing the reader's hands on the page. This allows readers to feel like they are running the test themselves instead of going through intermediaries like Alice and Bob.

Bub's goal was to use the medium of comics to provide a technical, visual experience of understanding scientific ideas. "We wanted to have a comic where you actually do the thought experiments," Bub said.

Tanya, Bub's daughter, is a programmer with a fine arts and philosophy of science background. She illustrated a few sketches for *Bananaworld* and all of *Totally Random*. At first, the comic was a continuation *Bananaworld's* Alice-in-wonderland and Bob-the-Cheshire-cat theme. But then, "Tanya called me up and said she was sick of the bananas," Jeffery Bub said.

In the next iteration of the comic, Alice and Bob became more realistic characters living in Oxford. Bob—now a post-doc—loses his funding in the first panel. He walks home and runs into a man selling a magic coin trick in the street. Bob buys it and discovers these are magically entangled coins that behave just like entangled particles.

After a while, though, "we couldn't get our characters to do all the things we wanted, like thing that electrons and photons do. I would call up Tanya and say why don't they do blah blah blah, and she'd say Alice wouldn't do that, or Bob wouldn't do that," Bub said.

So they got rid of Alice and Bob, and put the reader in charge of the coins. "The main character is really the reader," Tanya Bub said.

For APS's Head of Public Outreach, Rebecca Thompson, it's all about plot.

"One of the most important things about *Spectra* is making sure that it's plot-driven," Thompson said. She always wants to make sure that the story in her science comic works instead of just focusing on teaching physics.

"A lot of the time, educational comics suffer from a lack of plot. People want stories, they'll read stories; that's what engages people," Thompson said. "But a lot of [writers make] the educational piece the forefront of the comic… that's when you draw up people in superhero outfits, and they say 'I'm going to tell you about what I do in science.'"

Eleven years ago, Thompson wrote the first annual issue of *Spectra*, for middle school students. The newest issue, *Spectra's Energetic Escape*, is about the latest adventures of Spectra, the laser-superhero alter ego of a middle-school student. A competition based on topics in engineering and physics, modeled after escape rooms (with the prize of tickets to see the newest boy-band, The Free Radicals) goes awry and imperils Spectra and her friends. They are only able to save the day by exploiting conservation of energy, among other physics concepts, and using Spectra's laser superpowers.

For Thompson, her emphasis on plot goes hand in hand with an emphasis on character development. "Character development is a huge part of a lot of stories. That's what Harry Potter and Lord of the Rings do, by the end you feel like you really know these characters, and conversation makes that happen," Thompson said.

And Alice and Bob? "They make great names for pets," Thompson said. "I know physicists who have pets named Alice and Bob."

The author is a freelance writer based in Minneapolis.

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AGL: What was it about molecular biology that attracted you and continues to attract you?

VR: Molecular biology was going through a revolution, not unlike physics in the early half of the 20th Century.

AGL: You end the book by writing, "it still astonishes me that my career worked out at all after so many false starts and dead ends. My beginnings were not promising. There were so many times when I could have fallen off the edge and disappeared from the world of science, a fate I only avoided by changing track or starting over again." What advice would you give other people who feel they are "failed physicists"?

VR: Physics is a great training for every science because it teaches you quantitative and mathematical thinking, and that way of approaching problems is becoming increasingly important in every field, including biology. So you can choose. You have a wide range of possibilities if you have that fundamental grounding.

AGL: You talk a lot about luck, and how you can't underestimate it. How do you approach the role of luck?

VR: Be prepared or open-minded, so when you get a piece of luck you recognize it for what it is, and you capitalize on it. So if somebody tells you an idea you hadn't thought of, you could say that's luck. But it's up to you to recognize what it means and build on it, and that's not luck. It was Pasteur who said "Chance favors the prepared mind".

AGL: Have you always been confident in your career?

VR: No, definitely not. All of us have imposter syndrome and we all think we have lucked out and fooled everybody and are about to be found out. Most of us hope to retire before we are found out. It does affect people who are underrepresented, whether it is due to geography, or ethnicity or gender, more. [Underrepresented minorities] will feel imposter syndrome more because they feel "this is not really my club and I don't belong here". But people need to realize everybody has it, but as a minority you might think that more.

AGL: You write in the book that you don't like prizes. Has your view changed since winning the Nobel Prize?

VR: The Nobel Prize has changed my life enormously for the better. I have a voice and credibility and all sorts of things quite apart from the cash. But I think prizes apply a sports metaphor to science: it divides scientists into very few winners and the rest are losers, and in sports you can easily measure who comes first, second or third in a 100 meter race, but science is multidimensional and it is not always straightforward or even possible to say who are the top contributors to this field, because many people contribute to a field, especially one as complex as life sciences. So it's not a healthy situation and it's made somewhat more unhealthy by the kind of regard with which the community respects these prizes. Everywhere I go now my prefix is "Nobel Laureate," as if that's what defines me—not my work. It's not like they're saying, "you got the Nobel Prize because you did important work on the ribosome". It's more like "he's important because he got the Nobel Prize." It's confusing cause with effect.

BLOCKCHAIN continued from page 3

images. Users sign up with Hadron in order to run a browser-based app trained with that model. The app classifies the images passively, without input from the user—and can run, albeit more slowly, even when you are using your computer for other tasks. (Szu demonstrated the app to me while simultaneously running our Google Hangout video chat in another tab.) Hadron pays these users for their computing time with cryptocurrency.

Meanwhile, Aikon will act as a cryptocurrency converter between Peek and Hadron. Peek, who doesn't use cryptocurrency at all, will pay Aikon in regular US dollars using funds from research grants. Aikon essentially changes that money into cryptocurrency that Hadron accepts. Marc Blinder, the chief product officer at Aikon, compares this role to a credit card company when you swipe your card in a foreign country. "On the back end, Visa is doing all this work to deal with the fact you're an American and you've just bought something in pounds," he says. "But as a user, you don't have to deal with any of that." Aikon allows clients uninterested in cryptocurrency like Peek to seamlessly interact with cryptocurrency-based services like Hadron. Because of Aikon, Peek shouldn't have to deal with cryptocurrency fluctuations at all.

Both Hadron and Aikon are built on blockchain technology. As users' computers sort Hubble images on Hadron's app, Hadron uses a blockchain to keep track of their work and the cryptocurrency they earn. Aikon records its financial transactions on a blockchain. "Blockchain allows us to organize all those computers, divide up parallel computing tasks, and make sure everyone gets paid a fair amount for the portion of work they're doing," says Blinder. Anyone can download these blockchains. The point is to make all transactions publicly available so that nobody can own and sell your data, says Blinder. Instead, the two companies offer services as their business plan: Aikon sells streamlined interfaces for people to exchange crypto for regular currency, and Hadron builds easy-to-use machine learning models that can be deployed with distributed computing.

From a scientific perspective, Peek is pursuing multiple research questions simultaneously. First of all, he is testing how well his machine learning model can identify astronomical objects. He's also researching the blockchain itself as a data analysis technique. At the moment, he's not convinced yet that it can perform better than conventional computing. The distributed computing network currently saves Peek money compared to using commercial cloud computing, but he's not sure how effectively the technique will scale with more computers performing tougher computational tasks. "We're definitely still in an exploratory phase," he says.

Sophia Chen is a freelance writer based in Tucson, Arizona.

FLOW continued from page 1

mental manuscripts. Although the traditional topics of fluid dynamics comprise a main focus of PRFluids, the editors encourage the submission of papers in newer and emerging areas, including bio-related fluid dynamics, micro- and nanoscale flows, fluid mechanics of complex fluids and soft materials, geophysical and environmental flows, and papers on topics crossing the traditional boundaries of fluid mechanics. The scope of the journal is reviewed regularly to ensure that it continues to serve the needs of the community and captures the most interesting papers in fluid mechanics. Overall, the quality of the journal relies on authors to submit their best work and on referees to write thoughtful, well-reasoned reports.

To increase the visibility of research and to facilitate understanding by those viewing the PRFluids website, every paper published in PRFluids appears prominently on the website with a key image and a short description. Authors are invited to submit this content upon the acceptance of their paper, or work with an editor to create it. In August 2018 the PRFluids editors initiated a further means of highlighting that has become standard in other Physical Review journals, designating a few papers each month as "Editors' Suggestions." These are papers that the editors feel deserve special attention because of their particular interest, significance, or clarity.

Fluid science continues to expand its already wide breadth, both in the variety of topics covered and in the scales of interest. Over past decades, there have been many changes both in our understanding of fluid science and in how it is communicated, and it is impossible to predict what advances will occur in the years ahead. But whatever the future holds, the mission of PRFluids will be to continue the high standards of peer review and publishing carried over from both our progenitor journal and *The Physical Review*.

Gary Leal, currently Schlinger Professor Emeritus and active Research Professor in the Chemical Engineering Department at University of California, Santa Barbara, and John Kim, the Rockwell Collins Distinguished Professor in the Mechanical and Aerospace Engineering Department of University of California, Los Angeles, are co-Lead Editors of Physical Review Fluids*. Bradley Rubin, who joined the editorial staff of* Physical Review B *in 1999, has been the Journal Manager of* Physical Review Fluids *since 2016.*

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physics, and much more," said APS Vice President Philip Bucksbaum of Stanford University. "Almost at the same time, Donna Strickland and Gérard Mourou solved a key problem in laser science that quickly opened the door for both attosecond science and high-powered lasers."

Ashkin, an APS Fellow and recipient of the 2003 APS Joseph F. Keithley Award for Advances in Measurement Science, received the Nobel prize for his work at Bell Laboratories from the 1960s to the 1980s. There, he invented optical tweezers that use laser light to trap microscopic objects such as particles, atoms, and viruses. Optical tweezers are now used to capture and study living bacteria.

Mourou and Strickland developed chirped pulse amplification (CPA), a method of generating high-intensity, ultra-short pulses, when they were both at the University of Rochester. The scheme allows creation of powerful laser pulses that would otherwise damage the optical materials in the amplifiers. CPA is now a universally used laser technology and has paved the way for higher-intensity, ultra-sharp laser beams now used in millions of corrective eye surgeries. Mourou was the winner of the 2018 APS Arthur L. Schawlow Prize in Laser Science.

The concept of using lasers or light to move objects seems like something from a sci-fi film, but as Ashkin detailed in his 1970 PRL paper, focused, narrow beams of laser light generate optical forces that can displace small particles. Ashkin's original experiments with tiny transparent spheres showed that particles would move to the center of a laser beam, where the intensity was greatest. Using this concept, Ashkin demonstrated the use of laser beams for three-dimensional trapping of particles, now known as optical tweezers, in a 1986 paper, also published in PRL.

Ashkin and his colleagues first used optical tweezers to trap atoms but the technique is now widely used to study biological systems. The researchers realized the potential for optical tweezers to capture and manipulate living cells and viruses without causing physical damage. The use of Ashkin's invention has provided insight into the mechanics of fundamental biomolecular processes, like the process of protein synthesis based on motor RNA transcripts.

Mourou and Strickland's development of CPA has also led to a variety of applications from plasma physics to medicine—for example, the brief, intense light pulses created with CPA are used in eye surgery for vision correction. CPA also represented a turning point in laser science, allowing a dramatic increase in intensity of lasers after progress had been mostly stagnant. Between 1970 and 1985, the number of photons in a laser pulse had not been substantially improved because higher intensities caused optical damage.

Inspired by radar technology, Mourou and Strickland conceptualized CPA, which overcame amplification issues, as described in a 1985 paper—Strickland's first scientific publication. To avoid unhealthy intensities in the optical amplifier, the CPA technique separates the frequency components in a short light pulse and spreads them out over a longer pulse, thereby reducing the peak power. This stretched and "chirped" pulse is amplified, and then the frequency components are compressed back together, now with much higher intensity. The invention of CPA opened the field of laser physics to create increasingly intense beams for a variety of applications.

"There have been several Nobel Prizes associated with the development and application of lasers," said 2018 APS President Roger Falcone, a laser physicist at the University of California, Berkeley. "This year it is wonderful to see recognition of Art Ashkin's seminal work in using lasers to manipulate the motion of small particles, as well as Gérard Mourou's and Donna Strickland's impactful invention of a technique that enables the highest peak power lasers. The recognition of Strickland's critical contributions as a graduate student is noteworthy and inspiring."

The Nobel Prize, first awarded in 1901, is widely considered the highest honor in science, economics, and literature. The 2018 Nobel Laureates will be awarded medals at a ceremony in December, along with 9 million Swedish krona, half of which goes to Ashkin and the other half to Mourou and Strickland.

Additional Reading

A. Ashkin, "Acceleration and Trapping of Particles by Radiation Pressure" *Phys. Rev. Lett.* **24**, 156 (1970).

A. Ashkin, "Trapping of Atoms by Resonance Radiation Pressure" *Phys. Rev. Lett.* **40**, 729 (1978).

S. Chu, J. E. Bjorkholm, A. Ashkin, and A. Cable, "Experimental Observation of Optically Trapped Atoms" *Phys. Rev. Lett.* **57**, 314 (1986).

D. Strickland and G. Mourou, "Compression of amplified chirped optical pulses" Opt. Commun. 56, 219 (1985)

LIMELIGHT continued from page 2

fell out of widespread use.

Limelight also proved useful in the field, thanks to Scottish engineer Thomas Drummond, who was born in Edinburgh and showed an early gift for mathematics. Because of this he was recruited to use his facility with trigonometry to help survey the Highlands. The work also brought him to London, where he attended a lecture and demonstration of the limelight effect by Michael Faraday on November 9, 1825, and immediately realized its potential for surveying. He built a working prototype the following year, which is why it is called a "Drummond light" in certain circles. It's also why he is sometimes mistakenly cited as the inventor of the limelight. Drummond used his prototype in a trigonometrical survey of Great Britain and Ireland.

Despite his early successes and corresponding fame, Gurney's life also had its share of misfortune, notably failed business ventures and legal battles that left the once comfortably well-off gentleman nearly penniless. Inspired by Trevithick's Puffing Devil, Gurney invented his own patented steam-powered carriages, one that worked well enough that he successfully drove to and from London and Bath in the summer of 1829, averaging 15 miles per hour.

But it was not a commercial success, as the public feared the dangers posed by building a vehicle over a steam boiler. Gurney's daughter, Anna, defended the safety of her father's invention in a letter to *The Times* in December 1875, writing that she never witnessed any accident or injury, except "when the fair people [at Melksham] set upon it, burnt their fingers, threw stones, and wounded poor Martyn the stoker."

Gurney built another version, the Gurney steam drag, tethering a passenger carriage to a steam engine, and shipped two of them to Glasgow around 1830. One was damaged in transit to a military barracks, and even though Gurney warned the officers not to use it, they started the engine anyway. The boiler exploded, seriously injuring two people. He had better luck, at least at first, with a regular steam carriage service between Cheltenham and Gloucester. But a powerful lobby of those invested in horse-drawn carriages successfully convinced Parliament to establish heavy tolls on all steam carriages, which killed the fledgling business. Gurney ended up bankrupt and owing over 200,000 pounds in debts.

Gurney rebounded eventually, and was knighted by Queen Victoria in 1863. Unfortunately he suffered a stroke soon after and moved back to the Cornwall countryside, passing away on February 28, 1875. The inscription on his gravestone reads, "To his inventive genius the world is indebted for the high-speed of the locomotive, without which railways could not have succeeded and would not have been made." It didn't mention his invention of the oxy-hydrogen torch, precursor to the limelight. But the inscription under a stained glass window Gurney's daughter, Anna, sponsored in St. Margaret's, Westminster did.

Further Reading:

Porter, Dale H. *The Life and Times of Sir Goldsworthy Gurney, Gentleman Scientist and Inventor, 1793-1875*. Lehigh University Press, 1988.

WHAT NOW continued from page 5

out. His engaging presentation set the tone for the day noted Antonio Cuevas Rodriguez. "I really enjoyed the workshop and felt like I learned a lot about myself that I simply didn't know before," he said. "I am a rising junior at Stanford University, and never really thought seriously about careers outside academia until this summer. Peter Fiske's presentation especially spoke to me and helped me get an idea regarding what I could do after college."

After a section-provided pizza lunch, which students enjoyed in the new courtyard on the SLAC campus, the program continued. The afternoon session comprised two career panels, with panelists from diverse backgrounds ranging from academia, research companies, data science, government policy, patent law, national laboratories, publishing, and startup companies. After talking about their career paths and providing the students with lots of personal stories, the panelists were ready to take questions from the audience. There was not nearly enough time for all the questions so many conversations had to be continued during the break. After the official workshop program ended, the participants had the opportunity to tour SLAC National Accelerator Laboratory, which led them from the early days of SLAC, the construction of the linear accelerator, and the first North American web server, to state of the art research facilities like the Stanford Synchrotron Radiation Light Source and the Linear Coherent Light Source.

As with the 2017 workshop, many of the participating students pointed out that the event has helped them to develop a better idea of what to do with their degree and which options are available to them. Based on the feedback, the section will try to organize another workshop at SLAC in 2019. In the meantime, if you are interested in the materials you can find them at the meeting webpage (go.aps.org/2Q1uxw8). In addition the APS career page (aps.org/careers/) contains useful information as well as links to webinars – including a version of Peter Fiske's talk, "Putting Your Science to Work."

The author is Staff Scientist at the Lawrence Berkeley National Laboratory and 2018 Chair of the APS Far West Section.

The Back Page

Wanted: More Nobel Prizes for Women Physicists

By Vijendra Agarwal

Each October, the world awaits the Nobel Prizes, bestowed for "the greatest benefit to mankind." This year, Arthur Ashkin, Gérard Mourou and Donna Strickland won for their groundbreaking research in laser physics. The award to Strickland changed history, making her the third woman after Maria Goeppert-Mayer in 1963 and Marie Curie in 1903. The physics community will rejoice and welcome all of the 2018 Nobel winners, and especially that we now have a living Nobel woman physicist.

However, we should ask why only 3 of 210 Nobel physics laureates are women. While we celebrate the accomplishments of Strickland, physicists should refrain from too much back-slapping. In fact, the percentage of women Nobel Laureates in physics has decreased from 17% in 1903 to 2.5% in 1963 to merely 1.4% today. This trend and the long gap of 60 and 55 years for the last two women Nobel laureates must change.

Why is it important? First, the physics community will be intellectually much richer; second, it is the right thing to narrow the extraordinary gender gap; and third, it helps to give credit where it is due. And living women Nobel laureates will motivate more women to pursue physics.

It is very telling that today only 52 of all 935 Nobel Laureates are women. Goran Hansson [1], the secretary of the Royal Swedish Academy of Sciences (RSAS) admitted, "we are disappointed, … that there aren't more women who've been awarded [the Nobel]." He went on to say, "There was an even larger bias against women then... There were far fewer women scientists if you go back 20 or 30 years."

But even today, the RSAS is only 13% women [2], and this is the group that selects the physics, chemistry, and economics laureates. Is there bias against nominating women or a bias at the selection committee level? Are physicists and those in other disciplines not nominating deserving women, and why not? These questions cannot be easily answered with certainty. We know for certain that Alfred Nobel's legacy has boundaries and nuances. For example, no more than three can share the Prize, nominees and nominators are kept in confidence for 50 years, and the Prize is awarded posthumously only in exceptional circumstances.

1900-1963: Period of Physics Pride with "Nobel" Women

Marie Curie holds the singular distinction of receiving Nobel Prizes both in Physics (1903) and Chemistry (1911). She came from humble beginnings and had a tumultuous life: as a sister, she sacrificed and delayed her own education for her sibling's success; as wife, she stood by her husband and shared the Nobel with him, and as mother, she groomed and mentored her daughter to win the Nobel Prize in Chemistry in 1935.

What many of us may not know or remember is that Madame Curie's first Nobel Prize was not without hiccups. Reportedly [3], she was not even nominated by the French Academy of Sciences (FAS) in 1902. The Academy nominated only Henri Becquerel and Pierre Curie. If the Swedish mathematician Magnus Goesta Mittag-Leffler, an advocate of women scientists and a nominating committee member, had not intervened, history would have been very different. Mittag-Leffler wrote to Pierre Curie (husband of Marie Curie) advising him of the situation. In turn, Pierre wrote [3], "a Nobel Prize for research in radioactivity that failed to acknowledge Marie's pivotal role would be a travesty." Fortunately for the physics community, Marie Curie became the first woman to receive the Nobel Prize.

Was it because of some bias that Curie was not in the initial nomination? The answer may lie in what happened in later years. In 1911, FAS rejected Curie's bid to become a member by a margin of two votes. The reasons may be that she was Polish, a woman, and anti-Semitic newspapers had reported that she was Jewish [4]. In fact, Curie was never inducted into FAS (the first woman in 1962 was a French physicist and a student of none other than Marie Curie). Were these just aberrations or bias among FAS members (all men) against women? The present FAS is only ~8% women [2].

Following the death of Marie Curie's husband in 1906, one of his students, Paul Langevin (who was unhappy with his marriage) wanted to marry Marie Curie. As a result, some newspapers accused Curie of breaking up a good French home. A mob in front of Curie's house frightened her and she took refuge with friends. Yet against such odds, Curie received a second Nobel Prize in chemistry in 1911. Only a woman of her courage, conviction, and commitment could focus on science amid the turmoil. Was the bias a norm in the society those days or an "unconscious" effect?



Donna Strickland (left), Maria Goeppert-Mayer (center) and Marie Curie (right)

Does the nomination and the Nobel Prize in 1963 to Maria Goeppert-Mayer have a similar tale? Not quite, but there are some parallels. In the 1940s, she was a research volunteer at the University of Chicago where her husband Joseph Mayer was on faculty. Reportedly [5], she was not hired at the University because of its anti-nepotism policy. Goeppert-Mayer was also not offered a teaching position at Johns Hopkins or Columbia. She focused on her brilliant discovery of the shell structure of the atomic nucleus while working part time at Argonne National Lab. When her groundbreaking research became known, she was hired as a full professor at the newly founded University of California at San Diego in 1960. Her shell structure discovery, done in her "spare" time, led to the Nobel Prize which she shared with Hans Jensen and Eugene Wigner for separate but related work.

A quick comparison between Curie and Goeppert-Mayer suggests some similarities. Both were part of a team of three with only 25% of the Nobel Prize proceeds going to the women. One wonders why? They were also offered less than deserving academic rank in comparison to their husbands; it has not changed much for many women physicists even today. Curie appears to be a victim of explicit gender bias whereas Goeppert-Mayer may have faced an unconscious bias by the universities in not making an exception to hire her. Today, many universities go out of their way to solve the "two-body" problem in attracting scientific "power" couples. The available nomination database up to 1966 [6], also reveals that Goeppert-Mayer was a nominee for the Nobel Prize 27 times between 1955-1963, before she was finally chosen for the honor.

1964-2017: Missed Opportunities

History should not be erased, nor should it be forgotten. Consider three deceased women physicists, all examples of missed opportunities for Nobel recognition. Their excellent research represents three subfields of physics with direct impact on the award of Nobel Prizes to many men. It is not known if they were nominated or if the arguments by their nominators were not persuasive enough to bestow the honor on them.

Mildred Dresselhaus (died 2017) was rightfully dubbed the "Queen of Carbon." She predicted that a sheet of graphite, a form of pure carbon, could be rolled into tiny, cylindrical carbon structures called nanotubes. Her research work, at least partially, inspired two other Nobel prizes - 1996 Chemistry (for fullerenes) and 2010 Physics (for graphene).

Astronomer Vera Rubin (died 2016) did pioneering work on galactic rotation that supported the theory of dark matter. Rubin never won a Nobel prize for this work, although many physicists believe she should have. In 2011 Nobel Prizes honored three men (S. Perlmutter, B.P. Schmidt, and A.G. Reiss) for the discovery of the accelerating expansion of the universe attributed to dark energy, perhaps as groundbreaking as Rubin's work about dark matter.

Physicist Chien-Shiung Wu (died 1997) did experimental work that led to the Nobel Prize for Lee and Yang, but she was left out. The Wikipedia entry about Lee is very telling, "After the definitive experimental confirmation by C.S. Wu and her collaborators of parity non-conservation, T.-D. Lee and C.-N. Yang were awarded the 1957 Nobel Prize for Physics." UCLA physicist Nina Byers has called Wu's absence from the 1957 Nobel "outrageous" and the science historian at Brandeis, Pnina Abir-Am, did not mince words suggesting that Wu's ethnicity also played a role.

2018 and Beyond: Period of Hope and Challenge for Action

The award to Donna Strickland revives our hope yet again after 55 long years. However, we must not leave things to chance for the next woman Nobel physicist. We must move from hallway conversations to actively nominating our women colleagues. Contrary to belief, the Nobel Prize process is not entirely mysterious; a set of short videos [7] from an interview with a member of the Nobel Committee for Chemistry is a good source of how the selection process works. While not every physicist can directly nominate candidates for a Nobel, the Nobel Laureates in physics are among the long list of those who can.

The selection process begins with the Nobel Committee for Physics (now chaired by a woman with five male members) followed by a discussion among the larger group of the "Class for Physics." The members of these groups are not obvious but available with due diligence on the RSAS website [8]. The majority vote by the RSAS (with over 600 Swedish and foreign members) ultimately determines the Prize recipients each October. The RSAS members can also be contacts for nominations. Additionally, efforts by the science community to get more advocates for women on various committees will be needed. Remember that Mittag-Leffler's advocacy in 1903 changed the course of history with Curie as the first woman Nobel laureate.

The most urgent and effective course of action is to get women physicists nominated. This year, RSAS's Hansson said that the academy was taking measures to ensure more women are nominated [9] and "We don't want to miss anyone." Let us help RSAS in their stated goal and strive for 20 women physics Laureates by 2050. Our larger goal must be attracting and retaining more women in physics. We will be well served in the 21st century if the "Nobility" of Nobel Prizes has a narrower gender gap.

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