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APS NEWS

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GOVERNMENT AFFAIRS

APS President Sends Letter to House Science Committee Regarding COVID-19 Policy Initiatives

BY TAWANDA W. JOHNSON

As part of the American Physical Society's ongoing response to the COVID-19 pandemic, APS President Phil Bucksbaum recently sent a letter to the House Science Committee outlining policy initiatives that would help the physics community overcome challenges posed by the health crisis.

The COVID-19 pandemic has impacted APS members in myriad ways, including a severe reduction of research activity at many of the nation's laboratories and universities. And at the same time, APS members are also juggling additional responsibilities, including taking care of their children who are out of school or relatives who may need extra help.

"I want APS members to know that the Society is working hard to help get our physics community through and beyond this pandemic," said Bucksbaum.

Bucksbaum said that APS talked with researchers from a range of institutions to assess their needs. And based on that feedback and conversations among Society leadership, in his letter he asked Congress to take the following steps to help restore research after labs reopen:

- Provide partial- and full-grant cost extensions;
- Provide ramp-up funding to restart labs;
- Increase REU funding for summer 2021;
- Prioritize students in visa processing; and
- Enhance domestic STEM scholarships.

Prior to sending the letter to the House Committee, Bucksbaum said that APS addressed concerns from graduate students, post docs, and visiting scientists who are also grappling with negative impacts from the pandemic.

"Our immediate concern was to ensure that our graduate students, post docs, and visiting researchers continue to be financially supported from their grants during the crisis. Working with the APS Forum on Graduate Student Affairs (FGSA), we issued an advocacy alert, and hundreds of letters were sent urging science agencies to respond. We quickly received con-

LETTER CONTINUED ON PAGE 6

MEMBERSHIP UNITS

The APS Forum on Education

BY ABIGAIL DOVE

The Forum on Education (FEd) is a home for APS members interested in all dimensions of physics education—from physics pedagogy at the K-12, undergraduate, and graduate levels to the mentoring of early career scientists to expanding appreciation of physics in other scientific disciplines.

Formed in 1992, FEd helps members gain awareness of the many ways APS is involved in education. Additionally, three of FEd's four chair-line members (chair, chair-elect, and past chair) sit on the APS Committee on Education.

Some of the many educational initiatives within APS include PhysTEC (phystec.org), a project to improve and promote the education of physics teachers, STEP UP (engage.aps.org/stepup/), a high-school level program that encourages high school girls to pursue physics in their undergraduate years, and the Bridge Program (apsbridgeprogram.org), which

Catherine Crouch

offers mentorship and transition programs to increase the number of students from under-represented minorities who pursue physics PhDs. More information about the full range of APS programs can be found here: aps.org/programs/education.

Of particular note is the Effective Practices for Physics Programs (EP3) Project (aps.org/

FED CONTINUED ON PAGE 7

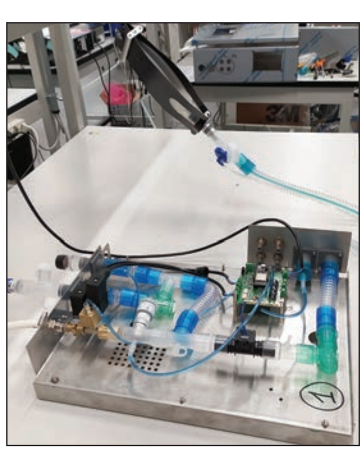
VIRTUAL APRIL MEETING

Physicists Mobilize to Combat Coronavirus

BY LEAH POFFENBERGER

As scientists around the world are using their expertise to combat COVID-19, physicists are no exception. A special session at the 2020 April Meeting highlighted some of the ways the physics community is responding to needs generated by the global coronavirus pandemic.

Sponsored by the APS Forum on Physics and Society, the session included speakers discussing three areas where physicists are already making a difference. Reiner Kruecken, deputy director at TRIUMF (Canada's national particle accelerator laboratory), spoke on behalf of the Mechanical Ventilator Milano (MVM) project, a large collaboration focusing on producing low-cost and reliable ventilators to meet a global shortage. Stephen Streiffer, Deputy Laboratory Director for Science (Interim) at Argonne National Laboratory (ANL) discussed the ways in which DOE labs are lending their expertise and infrastructure to projects such as modeling COVID-19 spread, imaging the virus in search of drug discovery, and more. Savannah



The Mechanical Ventilator Milano project seeks to make low-cost reliable ventilators for COVID-19 patients. IMAGE: MVM

Thais, a post-doc at Princeton University, explored big data and machine learning projects aimed at mitigating effects of the pandemic that physicists can get involved in, even from home.

International Collaboration Fights a Ventilator Shortage

The MVM project (arxiv.org/abs/2003.10405) was born out of

MOBILIZE CONTINUED ON PAGE 4

VIRTUAL APRIL MEETING

Exploring the Cosmos with Nobel Laureates

BY LEAH POFFENBERGER

Despite a sudden shift from in-person to online, this year's April Meeting, which took place from April 18 to 21, attracted thousands of attendees and featured an exciting slate of speakers. In years past, the Kavli Foundation Keynote Plenary Session has kicked off the first day of the meeting with talks from high-profile physicists, and this year was no exception: the keynote session featured three Nobel Laureates who have made extraordinary contributions to our understanding of the cosmos.

2019 Nobel Laureates James Peebles and Michel Mayor were joined by 2001 Laureate Eric Cornell for the Saturday morning session themed "Exploring the Cosmos." Didier Queloz, who shared the Nobel Prize in Physics in 2019 with Peebles and Mayor but was unable to attend the Saturday session, also spoke at the April Meeting during Tuesday's plenary.

As a pioneer of theoretical cosmology, Peebles, the Albert Einstein Professor Emeritus of Science at Princeton University, made early contributions that have influenced many aspects of cosmology research. In his talk "Exploring the Universe," Peebles recounted the development of theories and advances within the field of physical cosmology, which seeks to explain the large-scale dynamics and origin of the universe. Among his contributions to the field are the prediction of the cosmic microwave background

Eric Cornell

Michel Mayor

James Peebles

Didier Queloz

(CMB) in 1964, and the proposal of a theory of cold dark matter, a main focus of his talk.

Peebles recalled being urged by his advisor Robert Dicke, another accomplished cosmologist, to pursue the question of a theory of microwave radiation in the universe—a project he expected to last a short time before moving on to a new project. This led to their 1964 prediction of CMB radiation, a remnant from the early stages of the universe, which was soon detected by Arno Penzias and Richard Wilson, proving Peebles' and Dicke's predictions.

In 1982, Peebles proposed the existence of a new component of matter that would explain differences between the distribution of radiation and matter clumping in the early universe: cold dark matter. Two years later, he would add the cosmological constant lambda (Λ) to the theory to describe universe expansion due to dark energy, creating the ΛCDM model. The simplicity of Peebles' model led to its popularity: "The CDM concept was much more popular than I ever thought sensible—after all, it had not taken me much time to put together the pieces," he recalled.

The simplicity of the ΛCDM model in accounting for a number of properties in cosmology, like the structure of the CMB and the

COSMOS CONTINUED ON PAGE 7

EDUCATION AND DIVERSITY NEWS

Physics Department Chairs Conference Goes Online

Physics Department Chairs Conference

Save the Date

The free virtual APS/AAPT Physics Department Chairs Conference will take place June 18–19, 2020. Registration and further information are available at aapt.org/Conferences/depchairsprogram.cfm.

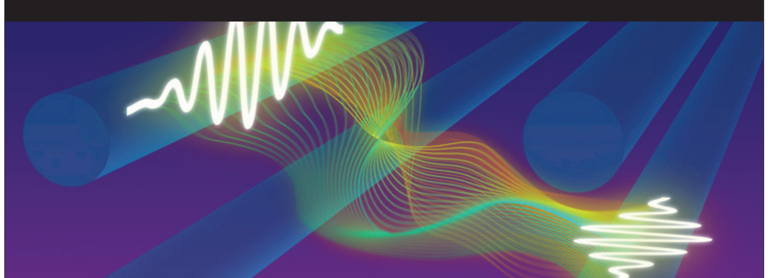
The conference agenda will include:

- A town hall with NSF Directors from the Division of Physics and the Division of Materials Research
- "Restarting the research enterprise" with APS Chief Government Affairs Officer Francis Slakey
- Discussions about experiences of these past few months on topics including: labs, assessing student work, assessing faculty in an online environment, synchronous vs. asynchronous teaching/learning environments, etc.
- Pre-release discussions of the "Effective Practices for Physics Programs" (EP3) Guide, currently under development, and set for initial release in December 2020. Possible topics include: Recruitment/retention of students, guide for new chairs, program review, advising and mentoring of students, and career preparation
- Session for new chairs (experienced chairs are encouraged to attend and share strategies)

STEP UP Online Community

STEP UP has launched an online community (hosted on APS Engage)—sign up at my.aps.org/STEPUP. You can join using existing APS credentials, or sign up for a free account. We have subcommunities for High School Teachers, Faculty/Professors, and Undergraduate Students, plus a central board for sharing ideas on encouraging young women to pursue physics degrees.

Join in the conversation today!



THIS MONTH IN

Physics History

June 16, 1874: Opening of the Cavendish Laboratory

The world-famous Cavendish Laboratory at the University of Cambridge has been home to scores of renowned scientists and profound breakthroughs, garnering 30 Nobel Prizes over the course of its history. Officially opened on June 16, 1874, the lab's moniker honors the 18th century physicist and chemist Henry Cavendish.

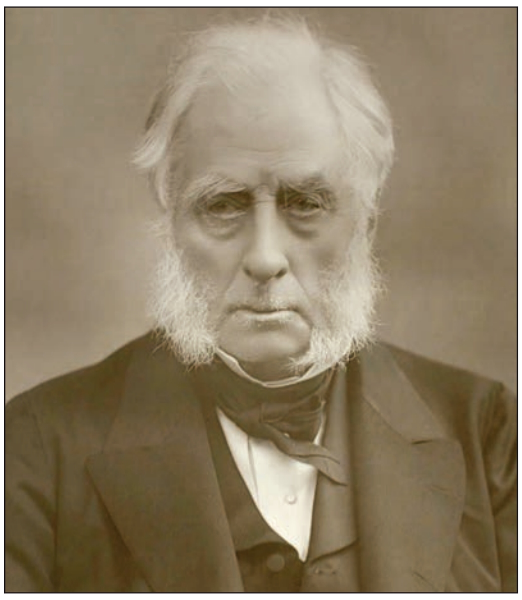
Born in October 1731 to great wealth and status, Henry Cavendish had a noble lineage that traced back to the Norman era. His father was Lord Charles Cavendish, and his mother, Lady Anne de Grey, died when he was just two years old. Young Henry attended a private school just outside of London, and studied at St. Peter's College, University of Cambridge, although he left the school after three years, having never earned a formal degree. Instead, he joined his father in London, and set up his own home laboratory.

It was Henry's father who introduced him to the meetings of the Royal Society, and Henry was elected as a member in 1760. He served on numerous committees, and published his first paper in 1766. He was well respected, but also a notoriously shy man, typically speaking only to one person at a time, and largely avoiding women entirely. (He left notes as instructions for his female servants.)

Cavendish is perhaps best known for the discovery of hydrogen, which he dubbed "inflammable air," produced when adding certain acids to specific metals. Other noted scientists like Robert Boyle had produced hydrogen, but it was Cavendish who realized it was an element. He also correctly identified carbon dioxide as exhaled (or "fixed") air, and produced it in the laboratory, along with other gases. He won the Royal Society's Copley Medal for his 1778 paper titled "General Considerations on Acids."

When his father died, Henry began dividing his time between a house in London and a home in Clapham Common, which is where he kept his scientific instruments and performed most of his experiments. Neighbors told their children that the house was "where the world was weighed," because that was Cavendish's most famous experiment. He used a modification of the torsion balance built by geologist John Michell to determine the density of the Earth, publishing his results in 1798. His experiment was so precise that the value he obtained was within one percent of the current modern value.

Home laboratories like Cavendish's were the norm for centuries of science history, and there was little infrastructure for educating students, apart from serving as an apprentice to a recognized scientist. The famous mathematician Isaac Todhunter summed up the prevailing attitude of the era when he opined, "Experimentation is unnecessary for the student. The student should be prepared to accept whatever the master told him."



William Cavendish, Duke of Devonshire, was a member of Henry Cavendish's family and a funder of the Cavendish Laboratory.

Attitudes began to shift in the mid-19th century, when William Thompson (Lord Kelvin) set up a physical laboratory in an old wine cellar for his students, although there was still very little in the way of formal instruction. By 1869, Oxford University had begun to build its Clarendon Laboratory, and a Cambridge committee issued a report calling for the establishment of a similar physical laboratory.

Unfortunately, there were insufficient funds to realize the committee's vision, which called for "the founding of a special Professorship, and of supplying the Professor with the means of making his teaching practical—in other words, of giving him a demonstrator, a lecture room, a laboratory, and several class-rooms, with sufficient stock of apparatus."

Eventually the wealthy university chancellor, the seventh Duke of Devonshire, donated the funds, and a then-relatively unknown young physicist named James Clerk Maxwell was selected as the first professor of experimental physics.

Henry Cavendish died in 1810, having never published the bulk of his scientific findings. But Maxwell took on the task of publishing the papers on the Cavendish electrical experiments in 1879,

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CAVENDISH CONTINUED FROM PAGE 2

100 years after those experiments were first conducted. Cavendish had anticipated such central concepts as electrical potential (although he called it the "degree of electrification"); Ohm's law; Coulomb's law; Richter's law of reciprocal proportions; and the concept of the dielectric constant of a material, among other discoveries attributed to other scientists.

Cavendish had even drafted a manuscript describing his mechanical theory of heat that prefigured modern thermodynamics. Maxwell was so impressed with the work that he renamed the laboratory after Cavendish. It was particularly apt since the founding Duke of Devonshire, William Cavendish, was a member of the same family.

Maxwell died young, at 48, before the full revolutionary import of his work on electricity, magnetism, and statistical physics became clear. (When Albert Einstein was told by a Cambridge host that he had accomplished great things by standing on the shoulders of Newton, Einstein replied, "I stand on the shoulders of Maxwell.") He was succeeded by another prominent physicist, J. J. Thomson, who discovered the electron.

Thomson in turn was succeeded by Ernest Rutherford, and it was under his leadership that James Chadwick discovered the neutron in 1932, and his students, John Cockcroft and Ernest Walton, split the atom. When Lawrence Bragg took over, he focused on x-ray crystallography and his research and the later crystallographic work of Rosalind Franklin eventually led to the discovery of the structure of DNA in 1953 by Francis Crick and James Watson.

Initially located in the center of Cambridge, the Cavendish Laboratory grew so rapidly that overcrowding became an issue, and it was moved to West Cambridge in the 1970s. A third site is currently under construction. The research focus is now in such areas as nanotechnology, cold atoms, and ultra-low-temperature physics, and no doubt there will be even more pioneering breakthroughs in the laboratory's future.

Further Reading:

Longair, Malcolm. *Maxwell's Enduring Legacy: A Scientific History of the Cavendish Laboratory.* Cambridge: Cambridge University Press, 2016.

INTERNATIONAL AFFAIRS

APS Partnership With Brazilian Physical Society Connects Young Physicists Worldwide

BY CARLOS HENRIQUE DE BRITO CRUZ

Since 2015, the American Physical Society and the Brazilian Physics Society (SBF) (the two largest physics societies in the Americas) have been promoting joint meetings to foster connections among young physicists from the US, Brazil, and other countries. The idea came out of discussions by the APS Committee on International Scientific Affairs (CISA), making use of funding from the São Paulo Research Foundation (FAPESP) in São Paulo, Brazil. In its mission to develop science and technology in the state of São Paulo, FAPESP has been pursuing a strong international agenda based on establishing joint research collaborations, sending Brazilian researchers for short (up to one year) stays abroad and bringing talented young and experienced researchers to participate in research activities in organizations in the state of São Paulo.

This partnership among APS, SBF, and FAPESP has so far launched four international meetings that have brought together young physicists from across the globe—two have been held in Brazil and two in the United States. These meetings directly support the goals of the APS Task Force on Expanding International Engagement. (As reported in the January 2019 issue of *APS News*, the Task Force had worked for 18 months to examine how the Society could increase its international engagement and better serve the international physics community. [1])

To develop these meetings, APS and SBF mobilized their membership to jointly prepare and submit proposals to FAPESP's "São Paulo Schools of Advanced Science (SPSAS)" program, which offers funding to organize two-week schools. These bring between 70 and 140 young scientists (early career, post-docs, last year PhD students) to São Paulo from any country to attend the lectures presented by a team of experienced researchers from São Paulo and from other countries.

In July 2015 Harry Westphal and Helio Tolentino (Brazilian National Synchrotron Light Source) and Ercan Alp (Advanced Photon Source, Argonne National Laboratory) organized the São Paulo School of Advanced Sciences on Recent Developments in Synchrotron Radiation (pages.cnpem.br/synclight2015/). The school took the opportunity presented by the development and construction, in Campinas, Brazil, of SIRIUS, a 4th generation 3.0 GeV synchrotron light source (see lightsources.org/2019/12/19/first-x-ray-microtomography-images-obtained-at-sirius/) to offer the participants the opportunity to learn about recent advances and see the light source during its construction phase. Ninety-six participants attended, 48 from Brazil and 48 from 17 other countries including the US, France, Argentina, Iran, Germany, Turkey, Canada, and South Africa. (Details are at aps.org/units/fip/newsletters/201509/sao-paulo.cfm.)

In 2016 the YPF was held in Baltimore, MD, the weekend before the APS March Meeting (March 12-13). It featured scientific presentations by young physicists, defined here as physicists employed in permanent professional roles who had completed their PhD degrees within 10 years prior to the Forum (sbfisica.org.br/v1/index.php?option=com_content&view=article&id=708). There were 50 participants, 24 from Brazil and 26 from the US. All contributed scientifically through parallel sessions or the poster session. Along with the scientific sessions, participants gained insights into career development and were afforded the opportunity to network with industry leaders and distinguished physicists from the US and Brazil. Panel discussion topics included university-industry cooperation and broadening the scope from a purely academic focus to introduce topics of interest to industrial leaders from FAPESP, APS, and SBF.

Poster presenters discuss their latest research at a joint meeting of APS and the Brazilian Physical Society.

The São Paulo Advanced School on Experimental Neutrino Physics took place in December 2018, in Campinas, SP (sites.google.com/site/spsasen/home). It was organized by Ettore Segreto and Ana Amelia Machado, both from the Physics Institute at the University of Campinas (Unicamp). The school benefited from the fact that Ettore and Ana Amelia are the creators of ARAPUCA, an outstanding neutrino detecting device to be used in Fermilab's DUNE experiment, for which they received the APS Early Career Instrumentation Award (news.fnal.gov/2019/12/dune-scientists-win-aps-early-career-instrumentation-award/) in 2019. The school was attended by 100 participants, 40 from Brazil, 15 from Europe, 15 from the US, 25 from Latin America, and 5 from Asia. There were 22 lecturers, 9 from the US, 2 from Italy, 2 from Spain and 11 from Brazil. Nobel Laureate Arthur McDonald gave a keynote speech via web conference. Focusing on experimental neutrino physics, the school had plenty of hands-on activities.

The most recent APS-SBF Young Physicists Forum was the São Paulo School of Advanced Science in Biological Physics, held at the South American Institute for Fundamental Research (SAIFR) in São Paulo on March 9-15 (ictp-saifr.org/school-on-biological-physics-from-molecular-to-macro-scopic-scale/). SAIFR (ictp-saifr.org), led by Nathan Berkovits, a professor at the Theoretical Physics Institute at the Universidade Estadual Paulista (UNESP), is an initiative put together by ICTP, FAPESP, and UNESP, to be a hub for fundamental science in South America. The Young Physicists Forum on Biological Physics was organized by Fernando Barroso (USP, Ribeirão Preto, Brazil) and Ralf Eichhorn (NORDITA, Sweden). There were 67 participants, 45 from Brazil, 4 from the US, 6 from other countries in South America, 7 from Europe, 3 from India, 1 from Canada and 1 from the Dominican Republic. In the opening session there was a talk by the President of the Brazilian Physics Society (Rogerio Rosenfeld) and a session about APS in which APS President Phil Bucksbaum participated through a video recording, APS Director of International Affairs Amy Flatten participated via Zoom, and I presented a deck of slides about APS and the opportunities it offers for international members and students. (This was the last event at SAIFR before the restrictions due to the pandemic took place).

The APS-SBF Joint Young Physicists Forums are highly praised by the participants in the post-event evaluations. They open opportunities for lifelong interactions and help advance research in physics in Brazil, the US and worldwide. They fit well in the strategy to develop science and technology in the State of São Paulo, Brazil, by bringing talented young researchers to visit the Brazilian laboratories and institutions so that some of the visitors may consider research in Brazil as an option for the future. Through the APS-SBF Young Physicists Forums, participants learn of many additional opportunities for future collaboration. Particularly, in the state of São Paulo, FAPESP offers a Young Investigator Award, which is a five-year grant for a person who wants to start a research career in the state. The grant includes funds for equipment, consumables, fellowships for students, travel. Each year between 50 and 80 young scientists from all over the world have such a grant approved (check out the list of Young Investigator

SBF CONTINUED ON PAGE 7

MOBILIZE CONTINUED FROM PAGE 1

the need to ensure ventilator access for those who need them during the COVID-19 pandemic. One way of meeting this need is increased production of high-capacity moderate-cost (that is, cheaper than typical high-end intensive care unit equipment) ventilators, a design specification met by MVM. From conceptualizing the MVM to manufacturing a working production model only took the collaboration four weeks, kicking off March 19 (see physics.aps.org/articles/v13/58).

"There was a tremendous effort to bring this forward," said Kruecken at the April Meeting. "We are now in the final stages of getting the system approved by the FDA, and plan on starting manufacturing as soon as we have approval—realistically in early May." The MVM received FDA approval on May 5.

The MVM was conceived as a low-cost, easy to operate ventilator, based around readily available parts. To achieve this, clinicians and experts in Italy, the United States, and Canada, along with manufacturers, gave their input on the final design, especially keeping needs of COVID-19 patients in mind. While some ventilators operate by pushing a certain volume of air into the lungs, MVM belongs to the pressure control class of ventilators, which is more suitable for patients with lungs damaged by COVID-19.

During the design period, pre-production models were sent to five different locations for testing and improvements: Naples, Valencia, Fermi National Accelerator Laboratory (FNAL), Canadian Nuclear Laboratories, and TRIUMF. The final MVM design, which can be operated in two modes, one for patients who are sedated in an ICU and another for patients who are transitioning off of the ventilator, is estimated to cost just around $5000—substantially less than regular ICU ventilators.

Kruecken attributes the rapid development of the MVM ventilator to the power of collaboration across nine time-zones and the ability to leverage physics expertise in gas and electronics systems used in particle physics projects.

"People want to help, and people bring whatever expertise they have to the table," said Kruecken. "The end product ... demonstrates how that expertise, taken together with a large international effort, can ... accelerate development in a marvelous way."

National Lab Infrastructure Supports Coronavirus Research

The Department of Energy (DOE) national labs are also applying their expertise and infrastructure in a number of areas, from structural biology research to epidemiological modeling. Each of the 17 national labs, which focus on areas from basic science to national security, have members participating in a new initiative: the National Virtual Biotechnology Laboratory. This consortium of the national labs is using DOE user facilities to tackle a variety of challenges in responding to COVID-19.

ANL, Oak Ridge (ORNL), Los Alamos, and Sandia National Labs are all collaborating on modeling COVID-19 spread in an effort to address key questions about the pandemic. By utilizing supercomputing capabilities, these models can anticipate how changes in behavior, like adhering to stay-at-home orders, modify pandemic impacts. ORNL is also one of several labs involved in addressing supply chain issues by applying advanced manufacturing techniques to produce critical medical supplies.

DOE user facilities, like the Advanced Photon Source at Argonne, have been employed to study the structure of the SARS-CoV2. According to Streiffer, using the Advanced Photon Source for this kind of research is not new, as about a third of the facilities' users were already conducting life-science research.

The National Virtual Biotechnology Laboratory is also tackling computational drug discovery by mobilizing artificial intelligence capabilities to find molecules that can interfere with one or more of the coronavirus' 28 proteins. Using data-mining with machine learning, about 30 potential therapeutic molecules have been identified for further testing.

"The work that we are doing... is only in many cases a minor pivot away from work the DOE was already doing, and we've been able to apply that really quickly to the COVID-19 pandemic without really redirecting work that people would've been doing otherwise," said Streiffer. "The DOE plans to continue this work—it's one of the reasons they established the National Virtual Biotechnology Laboratory to have a framework that could be sustained after the current crisis."

Open Science Recruits Physics Expertise

To conclude the session, Thais provided an overview of open science initiatives that will allow physicists to apply their skills during the COVID-19 pandemic. As most of these projects require familiarity with large data sets, advanced analysis models, and distributed computing, many physicists already have the skills to provide support. These open science projects range from epidemiologic modeling to non-invasive diagnostics to projects aimed at fighting the spread of misinformation about the virus.

Thais mentioned several modeling projects to track the spread of COVID, like HealthMap and CDC Flu Models that help predict hospital burdens. Other expanded modeling projects like COVID-Care integrate hospital resources into disease models to better predict risks in a specific area. Non-invasive diagnostics projects are applying technology to lessen testing burdens, such as using audio data to distinguish COVID-like coughs with a phone app.

Other projects Thais highlighted include: leveraging AI to improve telehealth to at-risk populations, supporting hospital systems by giving them a model to predict how supplies will be utilized (CHIME), and "info-demiology," tracking the spread of unreliable public health information online.

Thais urged attendees to consider ways where their skills might plug in to projects—even if not in a "super technical" way. She also encouraged "thinking locally and globally" to identify what needs exist both in one's community and in dealing with the pandemic at-large.

For more about the Virtual April Meeting visit april.aps.org.

GOVERNMENT AFFAIRS

APS OGA Begins Using Phone2Action, a New, User-Friendly Advocacy Software Platform

BY TAWANDA W. JOHNSON

The APS Office of Government Affairs (APS OGA) is moving to a new advocacy software platform called Phone2Action to provide APS members a more user-friendly way to impact change in science policy.

"Many of our members are busy teaching classes, conducting research, or even finishing PhDs, and APS OGA wanted to ensure our advocacy software is as accessible and user-friendly as possible. We want to further expand our impact on Congress and grow our base of members participating in advocacy," said Callie Pruett, Senior Strategist for Grassroots Advocacy.

Pruett added, "By placing a focus on accessibility and mobile-friendliness, Phone2Action gives us the platform to create those opportunities and engage a larger portion of our membership. Through Phone2Action, APS OGA will continue to advance the most modern and effective ways for APS members to engage in advocacy."

Pruett explained that an Action Center is housed on the APS OGA webpage and features the office's active advocacy campaigns pertaining to current science policy issues. These issues are chosen based on input from APS members and the Society's leadership. For each campaign, advocates will be given the option to write a letter, tweet, or make a call to their congressional representatives' and senators' offices, and they can choose to take any or all of these steps.

When APS members click on a campaign in the Action Center, they will be taken to a screen to view

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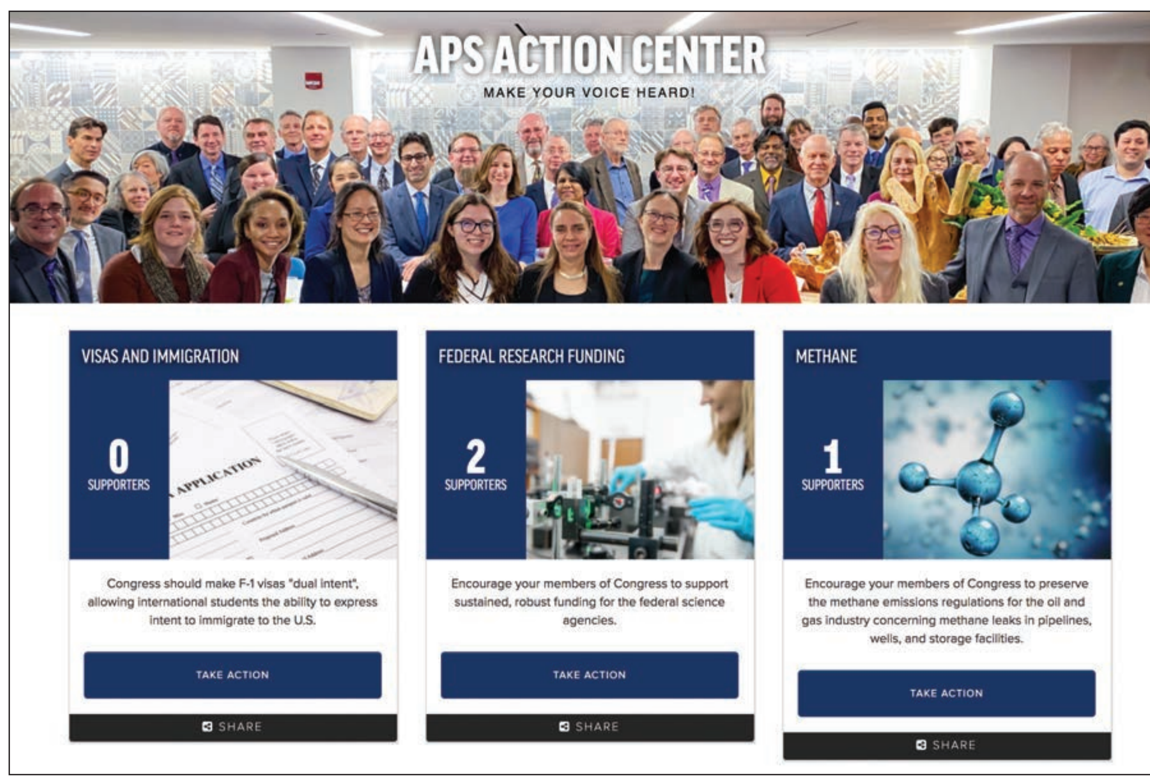
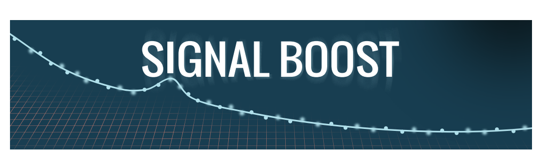


In the new APS Action Center, APS members can sign letters to Congress on key science policy issues



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

FYI: SCIENCE POLICY NEWS FROM AIP

'Physics of Living Systems' Survey to Delineate New Subfield

BY ADRIA SCHWARBER

The National Academies is currently undertaking the first-ever decadal survey of the "physics of living systems." The study committee will review recent accomplishments of the field and identify emerging research directions, while also making the case for it being a true subdiscipline of physics, rather than a mere application of physics tools and techniques to biological phenomena.

At a town hall event in April, committee chair William Bialek, professor of physics at Princeton University, traced the evolution of how past surveys have treated research at the intersection of physics and biology.

"If you go back to the early decadal surveys of physics, the interaction between the physics community and the phenomena of life was very clearly categorized as an application of physics to things outside the field," he said. Although the physics of living systems gained recognition in the early 2000s, he added, discussion of its work was nevertheless scattered across the physics decadal surveys prepared for the 2010s, such as the reports on atomic, molecular, and optical physics and condensed matter physics.

"What's new in this cycle is that we're being asked to review the physics of living systems as a subfield of physics that stands on its own, along with elementary particle physics, condensed matter physics, astrophysics, nuclear physics, and so on," he continued. "I think this is an incredibly exciting thing for our field. And we, as a community, have a great opportunity to sort of stake our claim to this part of physics and to the idea that what we do is firmly a part of physics."

Notably, the National Science Foundation, which is sponsoring the survey, already has a "Physics of Living Systems" program that funds research at scales ranging from single-cell dynamics to the collective behavior of animal populations. However, the study's statement of task does not define its scope based on that program. It more generally instructs the committee to consider ways NSF and other funding agencies could "overcome traditional boundaries" to support research on the physics of living systems.

Committee members have made clear, however, that the survey is not intended to cover the field of biophysics as it has generally been defined. Bialek noted that the study's title refers jointly to "biological physics/physics of living systems," which he said suggested that "even the people who are asking for advice are a little unsure about how to describe this enterprise."

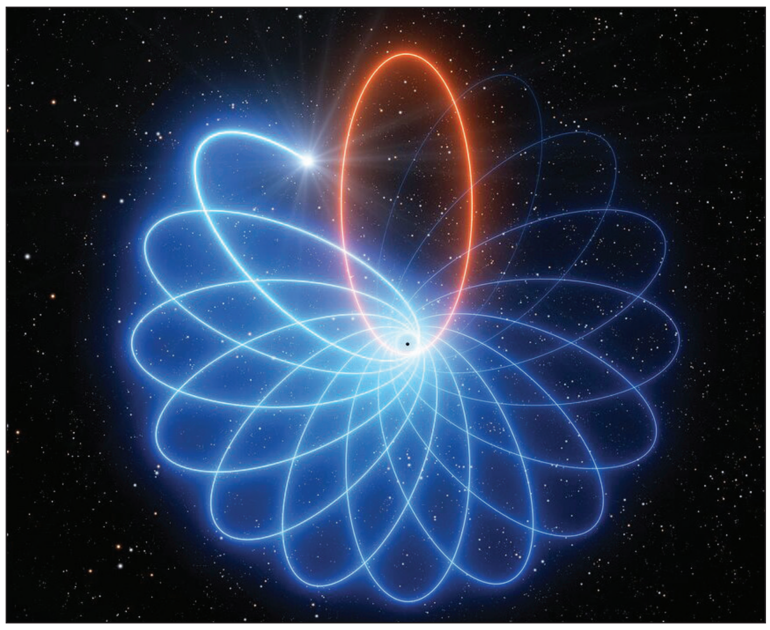
SURVEY CONTINUED ON PAGE 6

VIRTUAL APRIL MEETING

Going Deep into Black Holes

BY SOPHIA CHEN

Recent telescope and gravitational wave observations have enabled researchers to characterize black holes in new ways and perform tests of general relativity in the most dramatically warped spacetime environments yet. Even as collaborations suspend observing runs due to the ongoing pandemic, researchers still have a rich backlog of data to sort through for new insights, some of which were presented at the Virtual April Meeting.



Artist's rendition of Schwarzschild precession of a star's orbit around a black hole. IMAGE: ESO

Making Waves

At the meeting, researchers from the Laser Interferometer Gravitational-Wave Observatory (LIGO) and Virgo announced an unusual new signal, observed on April 12, 2019, from two black holes merging 2.5 billion light years away. Notably, this event involved a bigger black hole, 30 times the mass of the sun, and a smaller black hole, about eight times the mass of the sun. This contrasts with the 10 black hole mergers previously detected by the US-based LIGO and Italy-based Virgo, which involved black hole pairs around the same size.

Because this event looks so different from the others, it deepens researchers' questions about how black holes pair up. In particular, this signal defies a previous conclusion that black holes are likely "picky partners," as Maya Fishbach, a member of the LIGO collaboration, calls them. "From the first ten detections, it looked like they were very picky and only pairing with similar mass partners," says Fishbach, a recent PhD graduate of the University of Chicago. "With this latest one, it looks like there are some systems that aren't so picky."

It's an open question how this system could have formed. One potential strategy for solving this mystery involves studying the statistics of observed black hole mergers. For example, Fishbach has built simple models that describe the mass distribution of the black holes in the 11 detected events thus far. These models may help illuminate how these objects form: Researchers simulating black hole formation check if their models replicate Fishbach's statistics. While 11 gravitational wave signals make for a small data set currently, the collaboration has 56 candidate signals to potentially add to the mix.

The current statistics support the idea that black holes of a certain mass range don't exist, the so-called pair-instability mass gap. In particular, researchers have not found intermediate-mass black holes between 50 and several hundreds of thousands solar masses. It could be that stars of a certain mass become so-called pair-instability supernovae, which produce electron-positron pairs that completely blow apart the star, leaving no remnants.

A Wobbly Orbit

Reinhard Genzel, Director of the Max Planck Institute for Extraterrestrial Studies in Munich and leader of the GRAVITY collaboration, reported recent studies of the galactic center. Just two days prior to his talk, they published the first measurement of the precession of the star S2 around the supermassive black hole Sagittarius A* at the center of the Milky Way. This so-called Schwarzschild precession, in which the star's orbital path shifts slightly with every revolution, confirms a prediction by general relativity.

This measurement was an epic undertaking that began as early as 2002, when Genzel and his colleagues discovered that at its nearest approach, the star orbits just 17 light hours away from the black hole with an orbital period of about 16 years. Determined to observe the star's subsequent revolution, the group prepared for over a decade to develop and install new infrared instruments at the Very Large Telescope in Chile. Evaluating the star's orbit in 2018, they saw that its position had shifted.

The magnitude of this shift, which they measured to more than 5.5 sigma, matches general relativity predictions to about 15 percent. For a more precise measurement, they "need a star which is still closer [to the black hole]," says Genzel.

In 2019, the group also reported a test of a general relativity assumption called local position invariance using observations of this same star. They monitored light emitted from the star's hydrogen and helium atoms. As the star approached closer to the black hole, the stronger gravity redshifted the frequency of the light more. The collabora-

BLACK HOLES CONTINUED ON PAGE 6

COVID-19

New Webinar Series for Students and Early Career Members

APS is actively working on ways to help the physics community during the COVID-19 pandemic. In an effort to continue supporting our students and early career scientists, we have launched a new webinar series this summer. The webinars are designed to provide the information and resources you need to deal with some of the challenges this new era presents. For example, we'll cover topics such as the impact of new visa policies on international members, best practices for conducting research safely, and navigating your career during a pandemic. Additionally, these webinars will offer attendees professional development opportunities to better prepare for future careers.

Webinars held so far and archived for viewing:

- May 13: **Building Your Professional Path During COVID** by Crystal Bailey, Head of Careers
- May 19: **International Students & the APS Response to the Pandemic** by Francis Slakey, Chief Government Affairs Officer, and Amy Flatten, Director of International Affairs
- May 28: **Panel: Adjusting Lab Practices During a Pandemic**, organized by the APS Forum on Graduate Student Affairs (FGSA) and Forum for Early Career Scientists (FECS) leadership, with panelists from academia and national labs

We also surveyed the members of FGSA and FECS in May about professional development topics they might be interested in pursuing. Taking into consideration the results of the survey and feedback from members, we will be offering webinars on preparing and applying for positions in academia, industry, and national laboratories; on publishing your research in peer-reviewed journals; and on conducting virtual workshops on negotiation, communication, mentor/mentee training, and other topics.

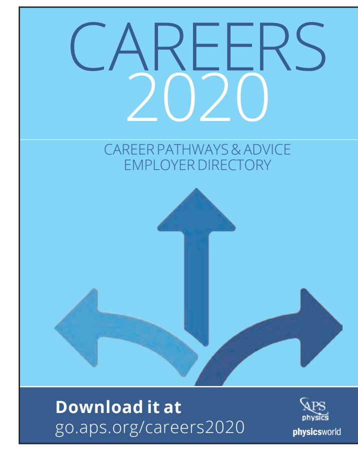
For more information, please visit our webpage and sign up for the email list to learn about upcoming webinars. All recent webinars can also be found on the same page. Additionally, if you would like to see a topic we did not list, please email us at careers@aps.org.

VIRTUAL APRIL MEETING

Supporting Early Career Physicists Virtually

BY LEAH POFFENBERGER

For students and early career physicists, deciding on a career path can be stressful in the best of times—and this stress has only increased during the coronavirus pandemic. To help counter some of that stress, the APS Careers team hosted a panel on non-academic careers at the 2020 Virtual April Meeting that included a virtual networking event, allowing job seekers to tap into the some of the same resources they might find at an in-person meeting.



For more on physics career opportunities, the APS Careers 2020 guide is available free online at aps.org/careers. A new edition will be available later this year.

The Sunday afternoon session "Meet Your Future: Career Panel and Networking," featured four speakers who shared their own experiences, offered career advice, and answered audience questions. Elizabeth Goldschmidt, Shannon Swilley Greco, Apriel Hodari, and Jenna Walrath brought diverse expertise to a lively panel discussion, moderated by Crystal Bailey, Head of Careers Programs at APS. After the panel, attendees and speakers were able to mingle and network via Zoom.

Goldschmidt is currently a professor at the University of Illinois Urbana-Champaign, but also has worked at the National Institutes for Standards and Technology and the US Army Research Lab. Greco, the Science Education Senior Program Leader at Princeton Plasma Physics Laboratory, and Chair-Elect of the APS Forum on Outreach and Engaging the Public, was on hand to talk about science education. Hodari is currently a principle investigator at Eureka Scientific Inc, researching equity in STEM. She also has a background in science policy and she offered advice on breaking into that field during the panel. Walrath, a Senior Process Engineer at Intel Corporation, shared her experiences working in industry as a physicist.

Despite holding very different types of jobs, the speakers agreed that the most important skill students need to build for achieving a career in their areas is communication. "There isn't a single career that wouldn't benefit from communication skills," said Walrath, adding that her line of work often involves problem solving and the ability to explain those solutions to stakeholders. Goldschmidt said that another valuable skill, especially for those pursing research careers is to "learn how to fail. Get good at trying [something], realizing it doesn't work, giving up, and moving to the next thing."

Many questions during the session touched on various aspects of choosing graduate schools, how to build up new skills while in school, and whether graduate school is even necessary. Bailey reminded attendees that 50 percent of physicists enter the workforce directly after receiving a bachelor's degree, with Walrath adding that many people she works with at Intel don't come in with advanced degrees. On choosing a graduate school, Hodari encouraged prospective students to find out about the culture of an institution and to talk to people about what their everyday life is like. Greco offered similar advice on choosing an advisor who will support career goals and projects outside of a thesis: "It's important when you're selecting an advisor to see how much they're invested in their graduate students—are they supportive of their development?" she said.

One participant asked the panelists how they found their current opportunities, and a similar theme emerged: picking an advisor—and friends and partners—that supported them. Greco and Walrath agreed that talking to people, seeking out opportunities, and taking risks were integral to their careers. "In terms of discovering opportunities, it's important to do some reflection on what you want," added Bailey. "You can change your plans."

The Virtual April Meeting session "Meet Your Future: Career Panel and Networking" can be viewed at go.aps.org/36aMnpx.

SURVEY CONTINUED FROM PAGE 4

He also contrasted the types of research that are presented at meetings of the Biophysical Society versus those of the APS Division of Biological Physics. "I think many of us find fantastically interesting things in both programs, but if you look statistically, you'll see that those are very different cross sections through or rather different pieces of the field," he said.

Speaking broadly about the evolution of the relationship between physics and biology, he said that around the turn of this century, "it became clear that if you came from the physics community and were interested in the phenomena of the living world, then you could still be a physicist, as judged by your physics colleagues."

"And so there is a distinction between biophysics as a branch of biology and the physics of biological systems or the physics of living systems as a branch of physics, and we are in a very deliberate sense charged with studying the latter," he added.

The author is a science policy analyst for FYI.

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LETTER CONTINUED FROM PAGE 1

firmation that science agencies will cover those salaries and benefits. Thanks to FGSA and our APS Office of Government Affairs (APS OGA), that effort benefited students in all disciplines, all across the country."

Tiffany Nichols, chair of FGSA, said the advocacy alert was crucial in getting the word out to Congress about how graduate students, post docs, and visiting researchers have been impacted by COVID-19.

"By providing a mechanism through which many voices can be elevated, this advocacy effort was able to ensure that graduate students, under federal grants, will continue to receive funds that cover their living expenses and wellbeing—which is especially critical during this pandemic," said Nichols, who is also an attorney and a doctoral candidate in the history of science at Harvard University.

APS has received positive responses from congressional and agency staff on several of its other requests, including from the State Department, whose staff confirmed that they had "heard from the scientific community" and would prioritize international students in the visa process. APS members had a significant impact by sending 2,240 letters to their members of Congress, urging lawmakers to support the recommendations in Bucksbaum's letter.

"APS members mobilized in 47 states plus the District of Columbia, reaching 56 percent of all House offices (243) and 94 Senate offices with this letter—a truly representative sample of our membership and a broad swath of the country," said Callie Pruett, Senior Strategist for Grassroots Advocacy in APS OGA.

Still, Bucksbaum pointed out, "there is more to do, and we will continue to work with agencies, Congress, and our organizational partners to get this done. And of course, we'll continue to work with APS members and keep them updated on our progress."

Francis Slakey, APS Chief Government Affairs Officer, said he was proud of the Society's response and added that physicists are enabling a global—and more equitable and effective— response to the pandemic through roles in various innovations that are aiding in combating the virus.

"APS will continue to partner with our members to ensure that the physics community gets through and beyond this pandemic. Physicists have played a critical role, not just in advancing effective policy responses, but also in developing technology that's critical to combating the virus," Slakey added.

To keep APS members updated on its overall COVID-19 response, including information related to its meetings, journals and supporting educators, the Society has a COVID-19 response page, which can be accessed at aps.org/about/covid-19/.

The author is the APS Senior Press Secretary.

PHONE2ACTION CONTINUED FROM PAGE 4

issue details and edit or personalize a pre-written message that will be sent to their members of Congress. A personalized message has proven to have a greater impact and gives the advocate an opportunity to highlight a unique story about a particular issue.

After the advocate clicks "send," a page opens with the option to tweet the advocate's members of Congress.

Finally, the software provides a single phone number to call. After listening to a short introduction from APS OGA, callers are automatically connected to each of their Representative's and Senators' offices, one at a time. A script is provided on that screen to help the advocate communicate the issue's key points when calling a congressional office.

"In other words, you can stop when you want to, and your actions will still be counted to that point. The entire process should only take a few minutes, and there are also options to share the campaign on social media or opt-in to receive emails or text messages about that particular issue in the future," explained Pruett.

The technology embedded within the platform is designed to get fast results.

APS OGA staff is excited to have the new Phone2Action platform available for APS members to use during this year's DAMOP meeting (June 1-5).

"Phone2Action provides the best service possible to our members, and our office looks forward to using the platform to partner with APS members who are committed to using their voices to effect change in science policy," said Pruett.

Mark Elsesser, Associate Director of Government Affairs, offered kudos to Pruett, office intern Sam McCormick, as well as the APS Communications and Information Technology departments for being instrumental in bringing the platform to fruition for the Society.

"Switching platforms wasn't a simple task. This new and improved advocacy platform for APS members is the result of the hard work and dedication of APS staff across multiple departments during the past few months," he said.

Added Francis Slakey, Chief Government Affairs Officer, "We are thrilled to use Phone2Action and look forward to keeping our members on the cutting edge of ways to effectively advocate for issues that are important to the physics community."

The author is the APS Senior Press Secretary.

BLACK HOLES CONTINUED FROM PAGE 5

tion confirmed that gravity shifted the helium frequency the same amount as the hydrogen frequency, as predicted.

Observations of such stars as S2 give astrophysicists the ability to test their hypotheses about extreme gravitational environments. "All of a sudden, we are using distant objects like tests in the laboratory," says Genzel.

More Donuts, Please

After the Event Horizon Telescope (EHT) collaboration published the first image of a black hole last year, fans have hotly anticipated their follow-up release, an image of Sagittarius A*. It's a top priority for the group, and they have amassed plenty of observations on this black hole already. "It'll be hopefully within the next year," says Michael Johnson of the Harvard-Smithsonian Center for Astrophysics, a member of EHT.

Although our galaxy's black hole is a mere 25,640 light years away, imaging it has proven significantly more difficult compared to M87, the orange donut published last year that is 55 million light years away. M87 is outside of the galactic plane, which means its light does not have to travel through much interstellar plasma before it reaches Earth. Not so with Sagittarius A*. "We're peering through our own galaxy, and it's like looking through frosted glass at the black hole," says Johnson.

In addition, our black hole is far more dynamic than M87, making it harder to reconstruct a clear image. "A day in the life of M87 is a minute in the life of Sagittarius A*," says Johnson.

The team is also studying other objects observed during 2017 and 2018. In April, they released an image of the quasar 3C 279, 5 billion light years away, which spews jets of plasma powered by a central supermassive black hole. In their analysis, the team traced the jet back to its launch point with spatial resolution finer than a light year.

Earthly Limitations

Despite the flurry of black hole research, the worldwide pandemic has made its mark on the community. Many ground-based observatories have been closed this spring. To protect the health of their staff, LIGO and Virgo shut down their facilities at the end of March, ending their observing run a month earlier than planned.

These shutdowns leave conspicuous gaps in their observing data. Unfortunately, the shutdowns coincided with the month of April, which is usually the optimal time for observing the galactic center, says Genzel. "We're not going to have data in 2020," says Johnson, of the EHT collaboration.

Prior to the shutdowns, the EHT collaboration had been planning to coordinate observations at 11 different sites this year, three more observatories since the first black hole image was taken. "It's heartbreaking," says Johnson. "We schedule these observations months and months ahead of time. We were right at the point of sending people to sites and finishing all the preparations when we had to make the call."

For now, researchers will make do with the data that they have. "The good news is that we're used to telecons," says Johnson.

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FED CONTINUED FROM PAGE 1

programs/education/ep3/), a collaboration between APS and the American Association of Physics Teachers (AAPT) to document evidence-based recommendations and best practices for undergraduate physics education. Recognizing that what makes for a thriving physics program at a private university is not necessarily the same as that for a liberal arts college, a large state school, or a community college, EP3 is developing a resource that will help a wide variety of physics programs strive for excellence given their particular opportunities and constraints.

At a time when a scientifically literate population is so crucial, many APS members have a greater stake in education than first meets the eye.

"Physicists who aren't teaching undergraduates are still mentoring and training graduate students and post-docs, or new hires in industry," explained FEd chair-elect Catherine Crouch (Swarthmore College). "Also, maybe as a taxpayer in a school district, or as the parent of school-age children, you would like to know what APS is doing to support the development of excellent high school physics teachers. There are many reasons for APS members to care about education even if they aren't directly involved in instruction."

Furthermore, in the age of coronavirus many APS members may be thinking especially deeply about physics education–particularly the urgent issue of how to optimize pedagogy for the remote online circumstances so many now find themselves in. "Human interaction is a very important part of learning," noted Crouch. "What we've learned about physics education in general is that student/faculty interaction is a precious resource. We need to know how to most effectively maintain as much as we can of the quality of in-person instruction over video conference."

FEd has a strong presence at the annual APS March and April Meetings, where it sponsors sessions to update the community on the many APS education initiatives, as well as a range of timely issues in the education arena. For example, recent FEd-sponsored sessions have addressed challenges and best practices for preparing future physics teachers, computation in the physics curriculum, and teaching physics to biologists. Several FEd-sponsored sessions from last month's social-distancing-friendly APS April Virtual Meeting are still available to registered attendees to watch at the meeting website, featuring topics such as data science in physics education and the necessity of supporting equity and inclusion in physics.

Beyond stimulating content at APS meetings, FEd publishes a regular newsletter detailing a variety of topics in physics education, including resources for physics teachers and professors, reports from recent conferences and working groups on physics pedagogy, and perspectives on engaging more women and under-represented minorities in the field. FEd chair Gerald Feldman (George Washington University) pointed out that the forum also sponsors two education-related awards: the Excellence in Physics Education Award, for a "sustained commitment to excellence in physics education," and the Reichert Award for Excellence in Advanced Laboratory Instruction, for "outstanding achievement in teaching, sustaining, and enhancing an advanced undergraduate laboratory course."

Gerald Feldman

Looking forward, the FEd Executive Committee hopes the future holds continued membership growth and opportunities for even greater engagement with the APS community as a whole on education-related issues. The forum's large membership base of 4,000 still represents only seven percent of all APS members–a "surprising" statistic, according to Feldman, given the number of APS members who have a stake in education as university faculty, advisors to graduate students, post-docs, and early-career scientists, and as products of education themselves. "APS has an impressive array of educational activities that maybe members aren't aware of," he noted. "People should want to know about what's happening in education, and we want to hear from them!"

Joining FEd, like all APS forums, is free of charge. "What I would love to see is for FEd to be an opportunity for all APS membership to recognize the many different dimensions of physics education, broadly speaking, and find their spot within it," noted Crouch. "What is the dimension of education they're involved in, that they care about, and how can they leverage what APS offers to be part of it?"

Overall, FEd stands out as an important opportunity for physicists to share ideas and resources about education, and a valuable conduit for APS members to learn about and contribute to the work of APS in the educational domain. More information on this unit can be found here: aps.org/units/fed.

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COSMOS CONTINUED FROM PAGE 1

expansion rate of the universe, has led to it being a prevailing model within physical cosmology, even without the direct detection of dark matter.

"We can only probe those aspects of nature that circumstances allow… maybe non-baryonic dark matter in its largest components will never be detected—that would be frustrating," said Peebles, to conclude his talk. "But let us celebrate how deeply we've been able to probe the world on a vast range of scales and just how much there is left to explore."

Mayor, a Swiss astrophysicist and Professor Emeritus at the University of Geneva, shared the 2019 Nobel Prize for his discovery, alongside Queloz, of the first extrasolar planet orbiting a sun-like star in 1995. His plenary talk, "Exoplanet: Twenty-five years of discoveries," detailed the past century of exoplanet research, from a time when very few exoplanets were expected to exist to today's search for Earth-like planets beyond our solar system.

According to Mayor, a big question in early 20th century astronomy was how many planetary systems exist in the Milky Way, and it wasn't until the last half of the century that it became apparent that the number is huge. The development of new ideas in the 1980s and 1990s for exoplanet research techniques and the first direct images of accretion disks from stars—which were indicative of possible planetary formation—paved the way for the identification of 51 Pegasi B, a Jupiter-like planet orbiting a solar type star.

In the past 40 years, since the first spectrograph for exoplanet research was employed in 1977, precision spectroscopy has improved to the point where exoplanet searches can identify lower mass planets. Other advances in exoplanet surveys enable investigations in a number of areas including the constraints of planetary formation, analysis of the chemistry of planets, and answering what Mayor called his "most important point: is there life in other places in this cosmos?"

To continue the exploration of the cosmos, Cornell introduced "The Three-Legged Stool," his metaphor for combining three approaches to better understanding the early universe and new particle physics: telescopes and "telescope-like-things," which includes LIGO; accelerators like the LHC; and precision measurement. Cornell, a professor at the University of Colorado Boulder and an atomic, molecular, and optical (AMO) physicist—he received his 2001 Nobel Prize for the first synthesis of a Bose-Einstein condensate—described the ways in which AMO physics can help traditional particle physics searches for new physics through precision measurement.

Cornell likened particle physics to the baby of AMO physics—which was once the physics of the smallest known particles—and emphasized how this relationship translates into fruitful research. "Our baby has grown to be big and strong, and we are very proud of it…but these days we sense that our baby needs us again" said Cornell. "And when your baby needs you, who can say no?" AMO and particle physics have teamed up in the past for searches for the electron's magnetic moment and studies of the Lamb shift.

A current AMO-particle physics project, which Cornell is working on, is an attempt to find evidence of CP violation—which explains why there is more matter than antimatter present in the universe—through efforts to precisely measure the electron's electric dipole moment. Cornell also discussed the applications of AMO physics to searches for dark matter, and the potential for new precision measurement results in particle physics. "I see this as the third leg of the 3-legged stool that we use to look for new or better cosmology, and new particle physics," he said.

Queloz, who shared half of the Nobel Prize in 2019 with Mayor for their discovery of 51 Pegasi B while he was a PhD candidate, provided more context to the new ideas sparked by their findings in his talk "The Exoplanet Revolution." The technology developed for the search that identified this exoplanet and the existence of such a planet with a large mass and close orbit to its star launched a change in the understanding of how planets form and behave within their solar systems.

The discovery of 51 Pegasi B, made possible by a combination of a high-resolution spectrograph and the availability of mini-computers for image processing, came as a surprise. According to Queloz, the discovery was first met with skepticism: "In a way, the planet was impossible," he said. Queloz and Mayor postulated that the planet's unexpected properties came from planetary migration and stripping of the planet, two things further research have revealed do play a part in structuring solar systems.

Further searches for exoplanets have produced a wide-range of planets with varying sizes and masses, with different orbital distances from the sun, but exoplanet searches have failed to turn up an "Earth twin." Queloz says the detection of planets with Earth-like regimes is difficult due to instrumental limits as well as noise produced by stars. But the search for such planets within other solar systems continues.

"The objects we've found forces us to rethink where we're sitting in terms of systems, and then there's a related question: how likely is it to have an [Earth-like] planet, and does that mean that we have to have [such a] planet to also have life?" said Queloz. "All these questions are bubbling into the community because we have so much diversity in planetary systems…trying to understand [these systems] and what…helps systems to be like our home. That's what I think the big challenge is for the next 20 years."

For more about the Virtual April Meeting visit april.aps.org.

SBF CONTINUED FROM PAGE 3

grants in Physics and Astronomy at bv.fapesp.br/50421) and the grant opportunity is open to persons of any nationality (as long as they are willing to move to a research institution in São Paulo to lead the research project for 5-years… or more if they like it here).

For the APS, the APS-SBF Joint Young Physicists Forums foster connections and strengthen relationships throughout the international physics community, a key goal of the APS Strategic Plan [2]. This is essential to the advancement of physics research in the US and for this reason APS highly values the international nature of science and international scientific cooperation demonstrated by these Young Physicist Forums.

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The author is at the Physics Institute, University of Campinas, Campinas, SP, Brazil. He is a member of the APS Committee on International Scientific Affairs.

THE BACK PAGE

Staying Motivated and Productive During COVID-19 as an Undergraduate Student

BY JACK MOODY

Social distancing, college campus shutdowns, and the transition to online learning have left most of our routines in tatters. But as the school year comes to a close, how do we budding physicists continue pursuing our personal and professional goals? What can we do during the summer to help us get ready for the fall?

Below is a list of thirteen topics we young physicists can work on to take control of our situation and keep moving forward regardless of social distancing or the uncertainties we now face. Our goal should be to make incremental progress on these suggestions in hopes of maintaining momentum during these difficult times.

Take care of yourself. First and foremost, make sure you are taking care of your physical and mental health. No progress can be made if you aren't up for the task. It's okay to take a step back from everything and take time to process current events. Do not let anyone make you feel the lesser for needing to take time for yourself. Everyone processes things differently. However, once you are feeling up to it, there are definitely some questions most undergraduates can tackle during the summer to keep progressing as young physicists.

Begin updating your resume and LinkedIn profile. The summer is a good time to do some self-reflection on all you've accomplished during the last academic year. During that self-reflection, write down all the new skills you've learned. Maybe it's soldering, programming in C++, or 3D printing. Regardless, you can update your resume and LinkedIn with these new skills and other relevant classes you've taken in the last year. You never know who looks at your LinkedIn profile or when you may need to send a copy of your resume to a potential principal investigator (PI) or employer, so updating it regularly is a good habit [1, 2].

Brush up on and bolster new skills. The summer downtime is a good opportunity to begin either learning new skills or strengthening current ones and there are plenty of online resources to help in that process. Take coding for example: there are tons of free resources online to learn new coding languages and delve into interesting projects. Some good starting resources are MIT OpenCourseware, Codecademy, Coursera, and YouTube [3].

Find research data online and do computational work for the summer. A way to get a direct application of those skills is by reaching out to professors at your university to try and participate in some computational research. A PI could potentially send you a dataset from their lab to do some self-study on. However, there are also many websites that offer datasets for free like Google Trends [4]. This could be a great way to strengthen computational skills, make new contacts, and possibly learn some new physics.

Set aside time for finding REUs. One of the most common concerns for an undergraduate is finding research opportunities during the summer. Research is a great way to prepare for graduate school and get some real-world physics experience. One way to prepare for this is to start looking for Research Experience for Undergraduate (REU) programs [5]. Be sure to bookmark ones you like or make a running list in a spreadsheet with the program name, school, URL, PI name, and projects being offered. Most deadlines for REUs aren't until January or February, so you have time to work on this. However, making an ongoing list of projects you find interesting can help make applications easier once it's time to start applying.

Stay connected to your community. It can be hard to maintain new or even old friendships when not on campus. But thankfully this is the age of technology! Make group chats and message each other at least once a week. You could set up a group where you play virtual board games, host a Netflix party, or even set up an informal seminar series with you and your friends to learn about each other's research and other summer projects. That way you can figure out what everyone else is up to and continue fostering your friendships.

It's okay to make last-minute class changes. Hopefully, you have met with your advisor and added all the classes you plan on taking in the fall. But is that one-off modern art history class still nagging in the back of your head? Or maybe that solid-state physics class? If so, reach back out to your advisor and get their thoughts on adding the class. Having even an introductory grasp of a broad range of topics is a great way to stay engaged and expand one's horizons. If you can't find room for it or don't want to be graded for it, try emailing the individual professor and seeing if you can sit in on the lectures, it's still a great way to learn about a new topic and you never know when the knowledge could come in handy. As an important aside, if you experience added stress due to COVID-19, it is okay to drop a class and take it at a later time.

Get involved in research or teaching in the fall. No matter where you are in your physics journey, it is never too late to get involved in research. It's a great way to learn new skills, support your resume, learn to work in teams, and collaborate with new groups of people. Begin on your college website, there is more than likely a "research" tab at the top of the screen, click on that, and begin reading through the different subfields your university offers and then what each professor does specifically. This is a great way to learn about your university and different fields of physics. Once you figure out four or five professors you'd be interested in working with, reach out to them! [6]. If your university doesn't have research, maybe try finding a teaching assistantship, join a physics outreach club, or a local Society of Physics Students (SPS) chapter. These are still good resume building opportunities that can help provide a new perspective on the world of physics.

Start looking at MS or PhD programs. The summer is another great time to start planning for the next big education goal in your physics career. Maybe it's a PhD or master's degree. If so, you can start looking at websites like the AIP grad school shopper to start finding programs [7]. You can also watch the Lunch with the Grads Panel session from the APS April Meeting for further advice from current graduate students [8]. Some things to consider: the kind of research done at the institution, geography (are you okay living far from home, or living in a city or rural area?), size of the department, stipend and benefits, student union, career assistance programs, funding opportunities, specific opportunities like working with industry or national labs, etc. You can follow the same recommendations as the REU paragraph to catalog schools you find interesting.

Begin thinking about your professional network. Whether you are applying to an REU, grad school, internship, or full-time job, the institution you are applying to will probably ask to speak to someone that knows you well or they will request a letter assessing your performance. It's best to start making a list of those people as soon as possible. Perhaps it is a professor whose class you did particularly well in, a professional you developed a rapport with, or your academic advisor or PI. Making a list of people who can vouch for you is paramount [9].

Develop that network. With everyone working from home, now is a great time to reach out to professionals you find inspiring to learn more about their careers and conduct short informational interviews. Informational interviews are a great way to learn about grad schools, jobs, careers, or types of research. These can be done over the phone or video and can provide some context and perspective on a potential project or career aspiration [10]. That person can also possibly help you get in contact with other professionals who could help foster future learning opportunities.

As always, the GRE is looming. Despite the uncertainty right now of when the GRE will occur, it is important to prepare as if it is still going to happen [11]. You can begin by finding resources online: the 1996 Physics GRE Subject Test is the usual go-to. There are also plenty of practice books online. You can also try reaching out to friends or grad students in your lab to see if you can borrow their copy (but be sure to treat it well).

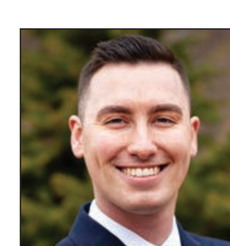
Start thinking about full-time jobs. Did you know that about 50% of physics bachelor's degree recipients go straight into the workforce? [12]. If this is your path, the summer is a good time to explore the APS Careers Website [13]. Once there, you can find great resources on career types [14], physicist profiles [15], and see available jobs [16] that you can use to determine a future career to pursue.

Once you are ready, begin chipping away at these things. A great way to make steady progress on these topics is by establishing SMART goals [17]. Beginning this adventure with Specific, Measurable, Achievable, Relevant, and Time-bound goals will allow you to stay on track and make sustained progress throughout the summer. For example, it could be looking at two graduate programs on Monday from 9 to 11 am, completing a chapter of an MIT OpenCourseWare class about Python coding by Wednesday at 6 PM, and reaching out to three potential professionals for an informational interview by Friday morning at 9 am. Making clear and specific goals helps you complete them more easily and faster.

We will get through this pandemic. All of us can make progress; it is important we stay connected as a community and rely on each other during these unprecedented times. We can all use this time to do some self-reflection and self-study on what we can do during and once this is all over.

Resources

1. Broad Institute Resume Help (go.aps.org/2y5UEON).
2. APS Resume Help (go.aps.org/2LJ2ktL).
3. Entrepreneur Article on Coding Teaching Resources (go.aps.org/3bDjwLs).
4. Example Sites with Free Datasets (go.aps.org/3bAZwcg).
5. NSF Physics REU Website (go.aps.org/2Z8D7Rc).
6. AIP Grad school shopper (go.aps.org/2uJJaeX).
7. Ohio State Undergrad Research Guide (go.aps.org/2Z9uiqe).
8. APS April Meeting Lunch with the Grads Panel Session (youtube.com/watch?v=qdYgFPYl1ww).
9. Stanford's Guide on How to Ask for a Letter of Recommendation (go.aps.org/3fRBJID).
10. Harvard Business Review on Conducting Informational Interviews (go.aps.org/3bvkrgV).
11. Stanford SPS Chapter GRE prep (go.aps.org/2WTIqBi).
12. APS Physics Bachelors 1 Year Later (go.aps.org/3cw4EzQ).
13. APS Careers Website (aps.org/careers/).
14. APS Job Prospects for Physicists (go.aps.org/3bwMi0t).
15. APS Physicist profiles (go.aps.org/2y46w3N).
16. APS Job Seeker (go.aps.org/3bzwbPy).
17. University of California SMART Goal Guide (go.aps.org/3bCofNy).



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