Forum on INTERNATIONAL PHYSICS

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Letter from the FIP Chair 2020

Luisa Cifarelli

Dear FIP Members,

As the 2020 Chair of the APS FIP (Forum on International Physics), I would like to briefly present the current activities and projects of the Forum, which has been, of course, significantly affected and concerned, as any other APS Unit, about the development of the COVID-19 pandemic.

Last year, in my quality of Chair-Elect, I had the pleasure to organize, together with the FIP Program Committee, the 2020 March and April Meetings, which had to take place in Denver and Washington DC. The program of the invited FIP sessions at the March Meeting had foreseen the participation of many distinguished speakers from Asia, Europe and the US on topics such as international physics with accelerators (XFEL, neutron spallation sources, plasma driven accelerators, etc.) and physics for development (SESAME project in the Middle East, fundamental physics and accelerator science in developing countries, especially in Africa, etc.). Also, a joint session on early-career scientists' international achievements, in particular in Europe, had been organized in collaboration with FECS (Forum on Early Career Scientists).

The cancellation of the March Meeting due to the COVID emergency took us by surprise, but for the April Meeting, which was timely transformed into a virtual meeting and turned out to be per se more successful than expected, we have been able to hold appealing FIP sessions which all gathered a very good audience. Two sessions focused on current projects and roadmaps of international physics with accelerators in the nuclear and the particle physics sectors, respectively, both in the US (with neutrino beams and heavy-ion beams) and abroad (at CERN, in Japan, etc.). The third FIP session was devoted to funding top-quality research in physics (in particular in Europe, through the European Research Council-ERC). It also included a final, touching talk by Ayşe Erzan (Istanbul Technical University), one of the winners of the 2020 APS Sakharov Prize for peace and human rights.

In its Executive Committee online meeting in April this year, FIP has decided to focus its 2020 activities on *Physics for Development*, in line with the desired international engagement of the APS. To this purpose, FIP has increased its funding contribution to the International Travel Award Program (IRTAP) to support research collaboration between physicists in developed and developing countries. It has also increased its funding of the Distinguished Student Program (DSP) to support overseas students to attend APS meetings, targeting special scientifically emerging regions of the world.

I would also like to emphasize the recent establishment of the FIP Outreach & Communication Committee (OCC), as a task force to improve FIP's visibility through its newsletter, web page and social media, to promote at large its many activities and initiatives, and to find efficient means to campaign for member recruitment at the international level, namely from big international laboratories to various kinds of institutions and centers around the world, including developing countries. To this end, many actions have already been taken.

- The newsletter has been relaunched with a new graphics layout, as you can see from this issue, and will be published from now on online only.
- Some expert voluntary help has been found to keep our web and social media pages updated, in collaboration with the APS staff.
- With the support of the Committee on International Scientific Affairs (CISA), a series of recorded and live online FIP colloquia have been planned on a variety of cutting-edge topics, from top world experts towards developing country audiences, starting in the fall of 2020 and targeting at first some specific countries in the Middle East.
- A project to produce a short (few minutes) video to promote FIP's international engagement has been sketched; This could be appropriately used as an introductory video for the above FIP colloquia and any FIP session at APS meetings.

The series of FIP colloquia, called *Physics Matters – Video and live colloquia as Physics for Development Initiative in COVID times*, aims to disseminate scientific culture at large and among the young (starting from graduate students), with particular emphasis on the role of women in science. Appropriate centers (universities, labs) in Jordan, Iran, and Pakistan are being identified and appropriate ways to ensure good video connections. FIP considers very important to act in COVID times promptly and is eager to take advantage of this outreach program of the contribution of other APS Forums, in particular: Early Career Scientists (FECS), Graduate Student Affairs (FGSA), Outreach and Engaging the Public (FOEP).

As you will read in this newsletter issue, FIP has been involved recently in the initiative launched by the APS Topical Group on Medical Physics (GMED) of an APS Online Community for COVID Resources/Research. In this respect, you can also find in this newsletter an article about an international collaboration project started in Italy, on the development and manufacturing of a new medical ventilator system.

Finally, let me say how deeply the international community has been moved by the recent episodes of violence happening in the United States and concerning black people. FIP strongly supports the *Statement Condemning Racism* by the 2020 APS Presidential Line, Speaker of the Council, and CEO (Philip H. Bucksbaum, Sylvester James Gates, Jr., Frances Hellman, David Gross, Andrea Liu, and Kate P. Kirby) of June 2, 2020, which condemns systemic racism and racial injustice of any kind that persist in the US and across the world.

Also, as Forum on International Physics, we were very concerned by the announced change of immigration rules in the US, luckily recently rescinded, which may have affected and penalized international students studying off-campus because of the pandemic emergency. FIP supports the position taken by the APS Leadership on this matter too since international students are an essential part of our community.

Let me end by thanking the FIP Chair-Elect (Alan Hurd), Vice-Chair (Joe Niemela), Past-Chair (Elena Aprile), all the members of the FIP Executive Committee, and last but not least the APS Director of International Affairs (Amy Flatten), for their wonderful help in this special year 2020.

Italy was one of the first countries to be affected by the COVID-19 emergency. Living in Bologna, I will never forget the nice and encouraging messages I have received from my friends and colleagues from other countries, and in particular from the United States, during the difficult months of Italian lockdown at the beginning of the year. Now the difficulty is general and it's my turn to express my closeness to all: let's all stay (virtually) together.

Luisa Cifarelli

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Message from FIP Newsletter Editor

Dear Readers,

These are extraordinary times. And we face extraordinary challenges.

As the Danish philosopher, Søren Kierkegaard, once remarked, "Life can only be understood backward, but it must be lived forwards." So it is with this pandemic crisis.

Without a doubt, these are extraordinary times, with several global socio-economic transformations and a significant impact on scientific research and education.

Public universities are experiencing state budget recisions and reductions, and private institutions and industries have seen operating income declining precipitously. Many research centers reduced or eliminated staff positions and even tenured faculty members at the universities are now worried. Future students are also concerned about the cost of college education and current students are struggling to pay tuition.

Several Physics Departments and labs worldwide have suspended research with almost no prior warning and students and staff have dispersed.

Although these are extraordinary times, they also bring exceptional opportunities. We have a generational chance to rethink scientific collaborations, programs, and structures, refocus priorities, and resharpen government policies and strategies.

The physics community demonstrated resilience and resourcefulness. Scientists worked tirelessly to keep the research and the education missions alive, often with inadequate public acknowledgment of the importance of their contributions.

APS, even if it had to cancel its conferences and required staff to work from home maintained most core activities and it is currently exploring new ways to disseminate scientific information and interact with the physics community.

Many APS Units, the FIP, among these, conducted online sessions to ensure the continuity of scientific exchange and the APS staff is continuously working hard to support, encourage, and enable virtual sessions.

APS outlines several policy initiatives aimed at helping the physics community get through and beyond the pandemic. If you want to learn more about the APS efforts on the COVID-19 go to the response page.

The APS's Office of Government Affairs (OGA) has worked hard on ensuring that graduate students and postdocs continue to receive support, despite the shutdown of labs and universities across the country.

We are living through a period that can only be described as the greatest act of solidarity in history, as people give up civic freedoms to save lives. And we all know that these extraordinary times will not end soon. It is difficult to imagine that the pandemic's traumatic experiences will be forgotten quickly or disappear entirely over time.

Even in these difficult times, the FIP is currently working to support the international physics community and serve its members better. We are preparing scientific sessions for the 2021 March and April Meetings and organizing activities to support scientists worldwide, with special attention to students and early career physicists, especially in developing countries. If there are actions you think we should be taking at this time, please let us know.

Recently, we refreshed the look of our Newsletter and have a new layout. We thank Marinora Sanges for designing the new cover and all the authors contributing to this issue.

I hope you will enjoy reading it and if you have any suggestion or want to submit articles, please send me an email (marialongobardi@gmail.com)

I send all best wishes to you and your families and hope you can stay healthy and strong.

Sincerely,

Maria Longobardi

FIP Newsletter Editor

Washington Statement on International Engagement in Physics

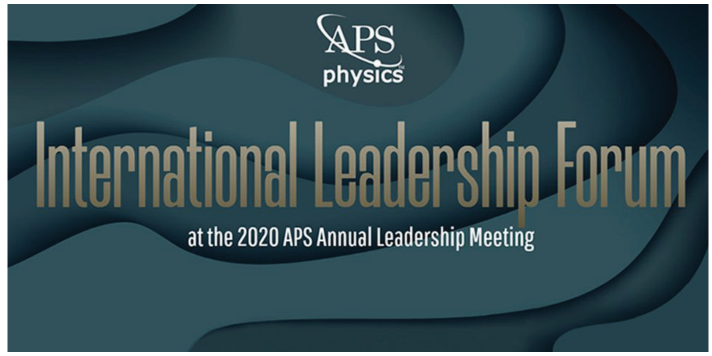
Fabio Zwirner

Initiated by David Gross, President of the American Physical Society (APS) for 2019, an "International Leadership Forum" took place in Washington DC on January 30-31, 2020. Participants included the leadership of APS and leaders from the global physics community, among them representatives from national physical societies and international research facilities, science policy experts and other eminent physicists. Fabio Zwirner attended from Italy, invited as Chairman of the Steering Committee of the International Centre for Theoretical Physics (ICTP) in Trieste.

The program included two panel discussions, a closed-session round table, and keynote talks by Steven Chu (Nobel Laureate and former US Secretary of Energy), David Reitze (Executive Director of the LIGO Laboratory) and Christopher Monroe (a leader in quantum information science). The first panel discussion, on International Collaboration, focused on the growing need for global facilities, such as the gravity-wave network, the Event Horizon telescope and the LHC at CERN, and on the need for international physics teams to advance progress using these instruments. The second panel, on International Competition, discussed how new science areas such as quantum information benefit from free exchange of people and knowledge across international borders, even in a world where security concerns and economic competition may be creating barriers to that exchange. It was stressed that collaboration on issues such as climate change, nuclear safety or health can only benefit all the parties involved. The round table discussed how we should respond to growing restrictions on international contact, especially in the US with respect to China, which could threaten future global engagement in physics. Observers from US federal science agencies and US government leaders in science policy were also invited.

In their concluding Statement, the participants in the round-table discussion affirmed the following principles:

1. The openness of fundamental research is critical to advance science, and ultimately improve the lives of everyone on the planet.
2. Freedom to travel for research or for international conferences is essential to realize the full potential of investments in fundamental research.



3. Global competition and collaboration in fundamental science drive innovation, and should not be limited by restrictions on participation, publication, communication, or travel.
4. Scientists who are studying or working outside their country of origin should be welcomed; they add great value through their presence and scientific contributions.
5. International cooperation in education, training, and research is critical to building scientific capacity across the world.
6. As scientists, we reaffirm our obligations to transparency. Concerns about conflicts of commitment, research integrity, and research implications for economic security must be discussed openly in the scientific community.

Learn more about International Engagement in Physics

- leadership2020.aps.org/forum/
- youtube.com/playlist?list=PLgxD9DiwxLGots29zA84eezUgzucPtlXe

Fabio Zwirner is Professor in the Department of Physics and Astronomy of Padua University, and Research Associate in the Padua Section of INFN. After getting his Ph.D. degree at SISSA, he carried out his research activities in theoretical physics of the fundamental interactions at Berkeley, CERN, INFN and the Universities of Rome Sapienza and Padua. He chaired the CERN Scientific Policy Committee from 2011 to 2013 and was member of the INFN Executive Board from 2015 to 2019. He is currently chairing the Steering Committee of ICTP, Trieste and serving in the European Research Council as Vice President for Physical Sciences and Engineering.

New FIP Executive Members

The FIP is pleased to welcome its new three FIP Executive Members in 2020.

Thank you for joining the community of International Physics!

Anne Matsuura is the Director of Quantum & Molecular Technologies at Intel Labs in Portland, Oregon (USA), where she leads research teams in quantum algorithms and architecture and in innovative sensing technologies. She left her position as the Chief Scientist of the Optical Society (OSA) to come to Intel in 2014. Previously, she worked in Belgium as the Chief Executive of the European Theoretical Spectroscopy Facility (ETSF), an organization of 250 scientists throughout Europe providing scientific collaborations, modeling and simulation, and open-source software to the public and private sectors. Prior to the ETSF, Anne held positions as a senior scientist at a strategic investment firm (In-Q-Tel), as a program manager for atomic and molecular physics at the U.S. Air Force Office of Scientific Research, and as a special assistant to the U.S. Deputy Under Secretary of Defense for Laboratories and Basic Science. She has also been a researcher at Lund University in Sweden, Stanford University, the University of Tokyo, and was an adjunct professor in the physics department at Boston University. Dr. Matsuura was a Fulbright Scholar at Nagoya University (Japan), a Japan Society for the Promotion of Science (JSPS) Fellow at Tokyo University, and was an American Association for the Advancement of Science (AAAS) Science and Technology Fellow. She has published over 35 articles in peer-reviewed journals and has 7 patents pending. She is an active APS volunteer. Her term as a member of the APS Committee on Careers & Professional Development is ending this year, and she is an industry mentor in the APS IMPact Program. She received her Ph.D. in Physics from Stanford University.

Joseph Niemela has served as a Research Scientist at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy, since 2003. He is presently consulting on ICTP's international programs, having for many years headed the ICTP Office of External Activities (OEA), its Training and Research in Italian Laboratories (TRIL) program, and its Applied Physics group. He conducts a research program in fluid turbulence with over 100 papers in peer-reviewed journals, and also coordinates optics and photonics activities at ICTP, providing research stays for experimentalists from developing countries in close collaboration with nearby institutions in Italy and Slovenia. Along with his research, he serves as Chair of the Physics for Development Group of the European Physical Society (EPS), Secretary of Commission 13: Physics for Development, of the International Union of Pure and Applied Physics (IUPAP), Treasurer of the International Commission for Optics (ICO), and was the ICTP observer on the Council of the Synchrotron Experimental Science and Applications in the Middle East (SESAME) project.

He was elected a Fellow of APS for his contributions to classical and quantum turbulence research, and was awarded the APS Dwight Nicholson Medal for Outreach, in recognition of his *outstanding leadership of the International Year of Light (2015) and for optical science and engineering outreach on a global scale*. He also received the Galileo Galilei Silver Medal by the Italian Physical Society (SIF) and shared the SPIE Educator of the Year award in 2011 as Director of a UNESCO program for training physics teachers in developing countries (ALOP).

Vasudevan (Vengu) Lakshminarayanan is a professor of vision science, physics, electrical and computer engineering and systems design engineering at the University of Waterloo. He was a "KITP Scholar" at the Kavli Institute for Theoretical Physics at UC Santa Barbara, and has held research and teaching and visiting professorship positions at UC Irvine, UC Berkeley, University of Michigan ,the University of Missouri, Indian Institute of Technology, Delhi amongst others. He is also an adjunct professor of Electrical and Computer Engineering at Ryerson University, Toronto. He also served on both of UNESCO's International Year of Light and International Day of Light planning/advisory committees and is, a founding member of the UNESCO Active Learning in Optics and Photonics Program. He is on the optics advisory board of the International Center for Theoretical Physics at Trieste, Italy, a consultant to the medical devices group of the FDA (since 2011), has represented the United States at two IUPAP general assemblies, was chair of the US advisory/liason committee for the International Commission on Optics, a finalist of AAAS Science and technology policy fellowship , a director of the Optical Society of America, the Strategic planning committee of the SPIE-International Society for Optics and Photonics, etc. He is a fellow of APS, AAAS, OSA, SPIE, IoP amongst others. At APS he was chair of CISA and has been on the Public Policy Committee as well as the CIFS. He has published widely in a number of areas and is the co-author/co-editor of over 20 books. His awards include: the SPIE Optics educator award (2011) and the Esther Beller Hoffman medal of OSA (2013). He has been/or is technical editor/associate editor for a number of journals and serves on a number of NIH study sections as well as other international funding agencies.

APS Fellows Nominated by FIP 2019

We are pleased to recognize and congratulate five of our members who have recently been elected to APS Fellowship upon nomination by the FIP for their significant contributions to physics and the advancement of physics throughout the world.

The APS Fellowship Program was created to recognize members who may have made advances in physics through original research and publication, or made significant innovative contributions in the application of physics to science and technology. They may also have made significant contributions to the teaching of physics or service and participation in the activities of the Society.

Michael Begel-Brookhaven National Laboratory

Citation: For international leadership in contributions toward a better understanding of jets and related physics in the ATLAS and DZero experiments, leading to advances in the trigger and data acquisition in the ATLAS upgrades.

Michael Markus-Benedikt CERN

Citation: For scientific leadership in the Future Circular Collider Study, and for promoting global collaboration in particle physics research to build the world's largest international collider.

Luisa Cifarelli-University of Bologna

Citation: For leadership in high energy physics and tireless efforts to strengthen international collaboration in physics.

Cristiano Galbiati-Princeton University

Citation: For the measurement of Berillium-7 and pep solar neutrinos and for the development of the liquid argon technology for the background-free exploration of dark matter at the Gran Sasso underground laboratory.

Alan James Hurd-Los Alamos National Laboratory

Citation: For seminal advances in the physics of soft matter and applications of neutron scattering, and for advancing international science diplomacy.

Distinguished Student (DS) Travel Support Program

The Forum on International Physics (FIP) has sought international students requiring travel support to attend the annual APS meetings in either March or April. Over the past four years, around a hundred undergraduate and graduate students have applied for this travel grant. The awardees were given between 500 and 2500 USD depending on the location of their institutions.

Students were chosen based on their academic and research excellence, teaching and community outreach activities. Special attention has been given to applications from less economically developed countries or working in those countries.

The DS travel program has successfully brought young researchers from distant lands to the annual APS meetings to interact with many of the world's leading researchers in Physics. The Forum on International Physics wishes to continue this very successful program and discuss ways to attain funds. If members want to support this very deserving program, please donate to the international program when renewing your annual dues with the society and mention the DS program specifically.

Fourteen students, from as far as India and Ethiopia, have been awarded in 2020. Here, in the following, the complete list of FIP Distinguished Students 2020.

DS Awardees at the March Meeting 2020

Binaya Kumar Sahu – India - Centre for Atomic Research, Tamil Nadu, India

Garima Aggarwal – India - Indian Institute of Technology Bombay, India

Simon Batzner – Germany - Harvard University, US

Helena Drueeke – Germany - University of Rostock, Germany

Md Shafayat Hossain – Bangladesh - Princeton University, US

Felix Sebastian Kratz – Germany -Technical University of Dortmund, Germany

Indrajit Maity – India - Indian Institute of Science, Bangalore, India

Hinako Murayama–Japan-Massachusetts Institute of Technology, US

Sofia Ferreira Teixeira – Portugal - University of Porto, Portugal

DS Awardees at the April Meeting 2020

Deniz Aybas - Turkey - Boston University, US

Meghna Bhattacharya - India - University of Mississippi, US

Alejandro Cardenas Avendano – Colombia - University of Illinois at Urbana Champaign, US

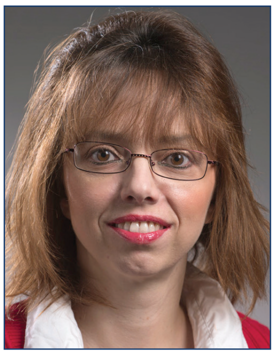
Alemayehu Cherkos – Ethiopia - Addis Ababa University, Ethiopia

Alberto Roper Pol – Spain - University of Colorado, US

What Your Country Can Do for You – COVID-19 in the Modern Era

Bill Barletta and Emanuela Barzi

When COVID-19 became a recognized pandemic in the U.S., the APS was prompt in responding to help its members. In April 2020, the Council discussed what the Society could do for the physics community at length through virtual meetings in these difficult times. The APS immediately acted as a source of evidence-based information by providing open access to a large number of papers from APS journals on topics such as pandemic models, statistical analyses, big data, etc.



Concurrently, most members of the scientific community were brainstorming on how to use their knowledge and experience for the benefit of the public. For instance, as published in APS NEWS in May, two theoretical physicists from the University of Illinois, Urbana-Champaign, Nigel Goldenfeld and Sergei Maslov, are credited with convincing Governor Pritzker of Illinois of the necessity of a lockdown in the state. In March, these multidisciplinary scientists modeled the effects of imposing a lockdown and the impact of its postponement. They found that without mitigation enacted by April 1, Chicago's ICU capacity would be exceeded. Governor Pritzker ordered the lockdown on March 21, preventing any overload of the state's medical facilities.

At the same time, in mid-March physicist Cristiano Galbiati, professor at both Princeton University and Gran Sasso Institute (searching for dark matter), was in Milan, sheltering with his family. Italy was one of the epicenters of infection after the outbreak in China. Italian hospitals had run out of ventilators to provide oxygen to COVID-19 patients with the most severe respiratory complications. A few days later, he started a collaboration that would soon involve more than 200 physicists, engineers, business representatives and physicians in over 10 countries. These volunteers broke into teams and met daily to discuss tasks and results while assembling and programming the so-called Mechanical Ventilator Milano (MVM). The MVM mechanical design – originating from the Manley ventilator from the 1960s – is made with purchasable parts and requires only compressed oxygen and electricity to run. However, the device's brain or control system is based on state-of-the-art electronics and software.

As much as the team felt comfortable within a large collaboration, which is typical in large physics experiments, the medical specifications were daunting at first. The body needs 15 breaths per minute, the lungs are extremely delicate, two modes of ventilation were required, and the machine had to be user-friendly for its operators. The researchers and the physicians eventually developed a common technical language and started building prototypes in Italy. Physicists coded the device's intelligent central command unit in consultation with doctors. By early April, completed prototype MVM units were being shipped around the world, including at Fermi National Accelerator Laboratory (FNAL) and in Canada, for rigorous testing.

Working from home, researchers didn't have access to physical labs and had to connect various components over the internet. A microcontroller in Italy could connect and receive software written in the U.S.; then, someone in Canada would test the interface on a touch screen. Nobel laureate Art Mc Donald led the Canadian effort, and several researchers contributed to the MVM at FNAL. Marco Del Tutto, a neutrino physicist and Lederman Fellow, worked on critical parts of the software and microcontrollers. A Lederman Fellow, Elena Gramellini, liaised with doctors on the front lines in Italy and created the MVM user manual. Both Del Tutto and Gramellini are alumni of the Italian Graduate Students Program at FNAL, from Summers 2014 and 2010. This training program's organizing team includes Prof. Emeritus Giorgio Bellettini and Prof. Simone Donati from the University of Pisa, and grants successful students with European Supplementary Credits.

In April, Eric Dahl, a FNAL and Northwestern University scientist, was able to use a breathing simulator at the Northwestern Simulation Training Center to test one of the first prototypes and to provide input to the MVM team. Jen Raaf, a neutrino physicist expert in liquid-argon experiments, worked with the medical device manufacturer Elemaster and led the effort to bring together all the elements needed for FDA emergency use authorization, which came on May 1. Others that contributed include Mike Wang, Anne Heavey, and Stephen Pordes. Raaf and Dahl are still testing several more prototypes with a breathing simulator at Cook County Hospital. Tests of the final product for certification in Canada and Europe are now underway. The MVM is designed to operate in two modes: full ventilation of a sedated patient and breathing support. The MVM is an open-source device and anyone in the world is allowed to make their own. The Elemaster company, just outside Milan, and other manufacturers build the first bulk production and get ventilators to where they are most needed.

Other facilities from the physical sciences that have proven critical in the present global effort to fight the COVID-19 pandemic are synchrotron light sources. Their high brilliance X-ray beams permit researchers to create maps at the scale of molecules and atoms of the 3-dimensional structure of proteins relevant to diseases. Light sources in the U.S. and Italy, initially designed to provide powerful beams of soft X-rays, Elettra Sincrotrone Trieste's Elettra ring and Berkeley's Advanced Light Source (ALS), have been committed to experiments aimed at identifying antiviral drugs, potential vaccines and diagnostic methods to tackle the current pandemic. Similarly, at hard X-ray light sources such as the APS at Argonne National Laboratory and NSLS_II at Brookhaven X-ray beamlines are being used to determine the atomic-level structures of SARS-Cov-2 components.

In Trieste, the experimental stations of Elettra synchrotron light source and FERMI free-electron laser are now open to researchers worldwide, who can request access to the beamlines through a special priority procedure perform remote measurements. Using highly sophisticated techniques in collaboration with the external users, Elettra research staff can perform urgent studies aimed at understanding the biological macromolecules that make up the SARS-CoV-2 viral particle responsible for COVID-19. Further experiments on Elettra are aimed at studying the effectiveness of known antiviral drugs.

Elettra Sincrotrone Trieste is also an active partner in the European project EXSCALATE4CoV (E4C), coordinated by Dompé Farmaceutici, and funded by Horizon 2020 through a special procedure needed for fast launch of research activities. The project's main goal is to identify to small molecules, safe in man, drugs active against COVID-19.

At the Berkeley Laboratory in the U.S., a small team of ALS staff members has several experiments for other scientists who controlled the work remotely. Only COVID-19-related experiments approved by ALS and Berkeley Lab leadership are allowed at the ALS. Berkeley leadership has noted that "None of the work involves any live samples of the SARS-CoV-2 virus that causes COVID-19. The samples include crystallized viral proteins that cannot cause infection. Additional samples to be analyzed include host-cell proteins required for infection by the virus."

The earliest experiments at the ALS have used beamlines that have been expressly designed to perform macromolecular crystallography. These experiments include work led by university research groups from the U.S., Canada, and Europe. The ALS is also performing proprietary experiments supported by major pharmaceutical corporations such as Novartis, Vir Biotechnology, and IniXium.

Macromolecular crystallography has long been a vital part of the research portfolio at the world's major synchrotron light sources. It is gratifying that these capabilities can be deployed rapidly in the fight against SARS-Cov-2 thanks to the many advances in beamline technology, precision robotics, and effective and secure telecommunication links between user researchers and the operations and experimental support staff at the synchrotron light source laboratories.

This article is based on information provided by Prof. Alfonso Franciosi, president of Elettra Sincrotrone Trieste and from Mr. Glenn Roberts, Jr. via an article in the Berkeley Lab daily report, *Elements*. Other sources that have been used include *Fermilab NEWS*, *Symmetry*, *University of Cincinnati News*, and *Kane County Chronicle*.

Emanuela Barzi is a Senior Scientist at Fermilab and an Adjunct Professor and Graduate Faculty at OSU. A 2012 Fellow of the APS and a senior member of the IEEE, Barzi has been an active member of the high-energy accelerator and physics communities for 25+ years. The Superconducting R&D lab that she founded is a world leading center in low- and high-temperature superconductor technologies for the next generation of particle accelerators. Barzi is a member of the team that this year produced a world-record field of 14.5 T for a Nb3Sn accelerator dipole magnet, is FNAL coordinator of NEWS and INTENSE, two Marie Skłodowska-Curie networks, and is a member of the Muon g-2 Collaboration. She has co-authored 239 peer-reviewed papers and book chapters with 5400+ citations. In 2010 she was awarded the Japanese "Superconductor Science and Technology Prize." Barzi also established extensive educational programs at FNAL for graduate students in Physics and Engineering, including the Italian Graduate Students Program at FNAL, that have benefited hundreds of young professionals, and has mentored 30+ students in her lab for internships, Masters and PhDs. Currently a Councilor of the APS FIP, she was recently elected in the APS Council Steering Committee.

William Barletta is Adjunct Professor of Physics at MIT and Adjunct Professor in the Faculty of Economics of the University of Ljubljana. He is Director Emeritus of the Accelerator Division at the Lawrence Berkeley National Laboratory. He is a member of the Scientific Council of the Centro Fermi and Museum in Rome, the Advisory Board of the John Adams Institute in the UK, the Scientific Council of DESY in Germany, senior advisor to the President of Sincrotrone Trieste, and Coordinating Editor-in-Chief of Nuclear Instruments and Methods-A and co-Editor-in-Chief of Physics Open*.*

He holds a Ph.D. (Physics) from the University of Chicago and is a Fellow of the American Physical Society and a Foreign Member of the Academy of Sciences of the Bologna Institute in Italy.

News from the APS: COVID Research and Resources Group (CRRG)

Cortney Bougher

The COVID-19 pandemic presents many challenges to the scientific community, but also presents opportunities for new research and education efforts. Many scientists are engaging in COVID-related work, and physicists are already contributing to the effort in various ways (e.g. modeling, imaging, technology). However, with the many restrictions and uncertainties of this time, many physicists may be researching in isolation and limited to local interaction.

To foster a coordinated community among physicists working or interested in COVID-related research, the APS Topical Group on Medical Physics (GMED), in partnership with other APS units, has recently created the new COVID Research & Resources Group (CRRG) on the APS Engage platform. APS Engage is an online community where users can participate in discussion forums, post and view resources, and network with other community members.

CRRG will serve as a meeting and discussion hub for COVID-related research, resources, and activities within APS. These activities may include broad-based COVID research webinars and events within focused interest groups (e.g., modeling, imaging, technologies) such as journal clubs, discussion forums, the formation of research consortia, as well as communications with partner organizations, societies, industry corporations, and news media.

FIP members are invited to join this new online community by logging into APS Engage with APS credentials and opting into the COVID Research and Resources Group (CRRG).

Cortney Bougher is the APS Director of Membership. Cortney received her master's degree in Engineering Physics from Appalachian State University in 2014.

Africa, Physics in Africa, and the *African Physics Newsletter*

James E. Gubernatis

Recently, American Physical Society began publishing the *African Physics Newsletter*, an email publication, composed by African physicists, reporting news of interest to physicists in Africa. In this short note, I will review the need for such a newsletter, highlight some of its articles, and discuss how you can help sustain its publication.

The newsletter emerged out of the desire of the APS's Committee on International Scientific Affairs to sponsor some projects that would benefit physics in Africa. To help identify possible projects, the Committee first sponsored a survey of the state of physics in Africa. From this survey, it was apparent that physics was a growing activity, but there were communication gaps among the African physicists, and between non-African and African physicists, that often hid what was happening. Some issues simply had to do with the nature of Africa and others had to do with the relatively small sizes and dispersion of the physics communities.

To take a closer look at some of these issues, let me start by saying that Africa a huge continent. You can fit China, India, the United States, and Europe all together within its coastline. To set the scale, Nigeria in the accompanying map of Africa (on the west about halfway south) is the size of Texas. Africa is also fascinatingly diverse politically, economically, culturally, religiously, and geographically, but often gets overly simplified by grouping the countries into those in North and sub-Saharan Africa. About 30% of Africa is desert, and although the Sahara Desert was once crossed by trade routes between the great empires of Africa, since the 17th century of the

common era it has been a natural barrier that has led to Northern and Southern Africa developing quite independently. That was yesterday. Today, there is the World Wide Web are the routes connecting all countries, but for Africa ,the Internet connects only about 13% of Africans, and even then, intermittent access to electricity and prices for data pose barriers. The common Anglophone and Francophone categories are also simplistic. Most countries have multiple official languages: South Africa has eleven.

An unfortunate fact about Africa is that it is a continent of developing countries. In fact, approximately 60% of the world's developing countries are African. Of the 55 African countries, only the Seychelles Islands, not the African country that usually first comes to mind, is in the high income or "developed" group. Twenty-four of the world's twenty-nine lowest income countries are African. It is this economics that has kept the size of physics small even in some countries that rank among the world's most populous.

In high-income countries, physics benefits enormously from the journals, newsletters, and meetings provided by our national physics societies. In Africa, the national physical societies are small (30 to 1000 dues-paying members). At the time of the survey, there were just nine. Those in South Africa and Nigeria are likely the only ones that regularly publish a newsletter and hold annual meetings. Almost all operate on a volunteer basis. Additionally, there are only

a few pan-African physics organizations and activities. As a consequence, the natural infrastructures by which physicists typically communicate what is happening in their country through their physical societies or across the continent through their participation and attendance in topical or sub-field conferences and workshops are weak.

The continent is changing. Physics in Africa is a growing activity. Countries are trying to establish more technologically based economies which has led to more agricultural, medical, science, and engineering funding and a greater need for training in physics. Research budgets are increasing, and as a consequence the number of physics research publications is increasing, as is the number of topical and regional physics meetings. There are at least two pan-African physics schools, the African School on Methods of Electronic Structure and Materials Applications (ASESMA) and the African School on Fundamental Physics and its Applications (ASP), that have enjoyed growth over their ten years of operation. An African Materials Research Society now exists, and the Abdus Salam International Center for Theoretical Physics (ICTP) recently opened its first institute in Africa, the East African Institute for Fundamental Physics in Rwanda. There are now fifteen national physical societies, and the Portuguese-speaking countries, in concert with the physical societies of Portugal and Brazil, have formed a physics union. Noteworthy is a team of African and non-African physicists being awarded an APS Innovation Grant. In short, there is a lot of physics happening that merits reporting to the physics communities in Africa and sharing with physics communities outside of Africa.

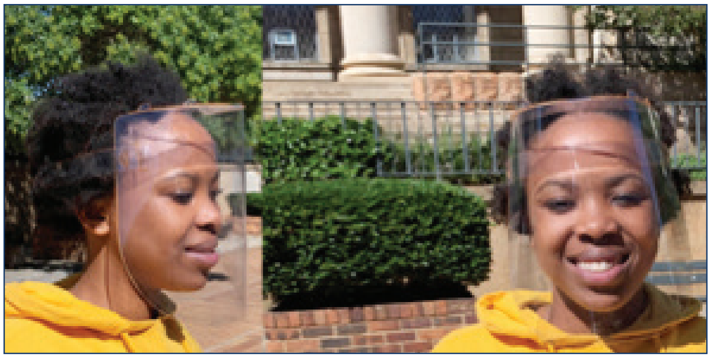
It is in this milieu that the *African Physics Newsletter* was started. The newsletter appears quarterly, is in English, and is distributed via email. Its subscription is free and open to all: you do not have to be a physicist or African to subscribe. A volunteer Editorial Board of African physicists gathers and copyedits the news articles. APS formats the articles into a newsletter and distributes the document via email. The sixth issue was published early June.

The principal features of the newsletters are a Save the Date column that lists and links to upcoming conferences and workshops and eight to ten short articles that usually link to larger articles or websites from which more information is available. Some of these articles are in fact announcements of the upcoming events and in some other cases are reports on what occurred at them. Important clients are ASESMA, APS, and their offshoots.

To give examples of the scope of the articles, several have reported recent notable research results. MeerKAT, the world's largest radio astronomy telescope, is coming on-line in South Africa. It has already come up with new discoveries, such as the discovery of giant radio bubbles at our galactic center and the location of missing hydrogen gas in the southern galaxy NGC1319, that have led to publications in *Nature*. Several articles have been about other types of recognition people have received for their research. For example, there was an article about a young man from Kenya whose Ph.D. thesis work done in Spain received Spain's physics "thesis of the year" award. Another article focused on a technology and innovation competition to develop sustainable technologies for Ethiopia, in which teams from multiple countries competed. A team of women engineers from Ethiopia won first prize "for developing a low-cost medical surveillance device that will meet the needs of midwives in Africa and ultimately save the lives of mothers and newborns."

Physics education is an important topic for the African community. As a computational physicist, I enjoyed the article on using QPython on Android smartphones for teaching and learning computational science and engineering. A university faculty member in Nigeria was faced with the difficulty of his students not having access to enough computers and computer time to learn the computational and programming skills. He was teaching Python, an easy-to-learn language rapidly gaining widespread use, so he instead adopted QPython, a version of the language that runs on Android smartphones, something to which students had easier access. STEM education is important throughout Africa, especially for women. One newsletter article recounted how the women on the mathematics and physics faculties at a university in Tanzania organized science camps for girls in high school, collaborated with the high school faculty at these camps on upgrading the curriculum and the teaching of certain topics, and worked with the students in hands-on laboratory settings. The result was that more young women beginning STEM majors at

The African School on Electronic Structure Methods and Applications (ASESMA) aims to develop the knowledge and skills of electronic structure methods and applications to materials problems relevant in Africa. This group photo is of the students and instructors at is 5th biennial school in Ethiopia.



Wits University face shield worn by Tshwarela Kolokoto, a volunteer in the South African university's School of Mechanical, Industrial and Aeronautical Engineering, to meet the national demand for personal protective equipment (PPE) and medical supplies as healthcare facilities in the country were seeing a shortage in these supplies during the present COVID-19 pandemic.

the universities were better prepared, and consequently graduated in these majors at a higher rate.

Perhaps the most unusual article was about how physics was helping to age and study the cause of the deaths of several Baobab trees. (Google them!) These are relatively common in African grasslands and many are believed to be several millennia old. Their age and trunk structure make traditional tree ring counting methods useless for determining their age. Their longevity translates in local spiritualisms into immortality, so the death of a tree is a big deal. Mass spectrometry and radioactive carbon dating are being applied. While unusual, this article gives an answer to the question that African physics often faces, "What use is physics?" In fact, another news article answering this question with respect to the real-time spread of the COVID-19 across Africa used this question as its title.

It is now natural to segue to the special focus of the newly published issue. It was devoted to the effects COVID-19 has had on the African physics community and the response this community is giving to the challenges the pandemic presents. What was special was the feature "Letters from the Editors" that gave very personal accounts of how the virus has affected their teaching, research, and family life. These accounts underscore once again today's oft-repeated statement that we are all in this together.

The future of the newsletter depends on its readership and its ability to keep discovering interesting news articles. Let me conclude with a call for help on both items. I encourage you and ask that you to encourage your colleagues to subscribe. Subscriptions are free and easy to start. To do so, one simply has to go to the website go.aps.org/africanphysics.

A major need is help in identifying and sustaining the number of news articles worthy of publishing. Gathering the news is the principal duty of the newsletter's editors but because of the size and complexity of Africa, the Editors cannot be aware of everything. Simply put, the communication gaps the newsletter are trying to bridge present challenges to the actual publication of the newsletter. While the Editors have identified many of the published news articles to date, the newsletter has also profited by unsolicited contributions and needs to increase these to continue its success. Planning an upcoming workshop or conference in or with African colleagues? Hosted some African students during the summer? Had a student from Africa do an outstanding thesis or was the lead author on an article published in a notable journal? Someone from Africa just completed a sabbatical in your department? Looking for some really good students and post-docs? etc. etc.

To contribute or suggest news items, the simplest thing is to contact the Editor-in-Chief, Prof. Igle Gledhill of Wits University igle.gledhill@wits.ac.za for guidance. Otherwise, one can contact another member of the Editorial Board. Their names and more specific information on how to contribute are given in the newsletter. Articles are short. Thank you for your help.

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*James E. Gubernatis received his Bachelor of Science Degree in Physics from Loyola College (now Loyola University of Maryland) and his Master of Science and Doctor of Philosophy degrees in Physics from Case Western Reserve University. On completing his post-doctoral work at Cornell University, he went to the Los Alamos National Laboratory as a staff member. After 43 years there, he retired in September 2018 and is now enjoying his status of Guest Scientist. In 1993, he was named a Fellow of the American Physical Society. He is a past chair of the APS's Division of Computational Physics and IUPAP's Commission on Computational Physics. Presently, he is a member of APS's Committee on International Scientific Affairs, for which he helps oversee the publication of the A*frican Physics Newsletter.

Mechanical Ventilator Milano (MvM)

Eugenio Scapparone

The rapid and widespread of the Covid-19 has created an urgent demand for ventilators on a global basis, exceeding current national production capacities and supply from other countries, especially in some areas where imports are problematic.

This need has motivated a team of researchers, scientists and companies to develop a project for a mechanical ventilator called MvM (Mechanical ventilator Milano) [1], a reliable and easy to use device, that can be produced quickly and on a large scale, using components available on the market. The idea behind the MvM project is inspired by the ventilator designed by Roger Manley in 1961, based on the possibility of using the gas pressure of an anesthetic machine as the motive power to ventilate the patients› lungs.

MvM relies on the same principle of simplicity but does not use a volume measurement system supplied to the patient directly at each respiratory cycle. Instead, it uses a pressure-controlled mode; it is based on a system of electro-mechanical valve and pressure, and oxygen sensors connected to an electrical control unit.

The heart of the device consists of a microcontroller that implements the logic for managing the respiratory process and dialogues with a chip with a processor. The Graphic User interface is provided by an LCD display that monitors the patient›s parameters and makes system settings available for the medical personnel. Fig. 1 shows an illustration of the MvM ventilator and the breathing circuit.

The broad spectrum of knowledge required to build an electro-mechanical pulmonary ventilator ranges from medicine to electronics, from sensor technology to software development:

The collaboration between a large network of research organizations and active companies was mandatory for the initiative›s success in areas relevant to the project. The MvM project was born on the idea and initiative of some researchers of the international collaboration Global Argon dark Matter (GAdM) engaged in research activities on dark matter, an invisible component of the universe, working at the National Laboratories of the Gran Sasso of iNFN and in Canadian laboratories of SNoLAB and TRiUMF.

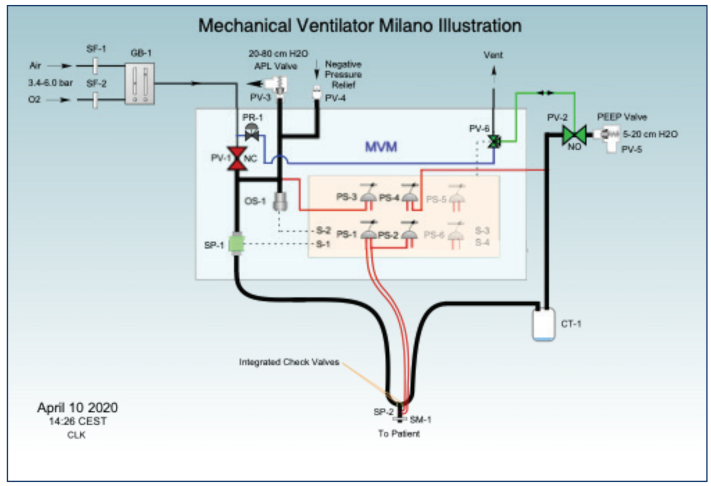

Fig 1: MvM ventilator and the breathing circuit

More than 150 researchers from Italy, Canada, the USA and several European countries, are involved in this project; From Italy, a large team of physicists, engineers (mechanical, electrical, electronic) and physicians from INFN, CNR, GSSiI, eight universities (Unibg, Unibs, Unimi, Unimib, Unina, Unipv, Unica and Uninsubria) and six industries: Azpneumatica, Belpower, Camozzi, Elemaster, Nuclear instruments and Saturn Magnetic.

In the last weeks, a prototype of the MvM device (fig. 2) was developed at the Elemaster company, based on physicians› recommendations, particularly pulmonologists and anesthetists.

The FDA (Food and Drug Administration) authorization was issued in May, within the scope of the emergency use.

The project is currently in the advanced testing phase, required for CE certifications, carried out by researchers from Italy and other countries.

The MvM prototype uses a controlled pressure ventilation mechanism (PCv) and can be used in two different modes, independent or patient assisted. The system connects directly to a pressurized medical oxygen line and it is based on the regulation of the flow necessary to provide a mixture of air and oxygen to the patient at the appropriate pressure.

Fig 2 MvM device

The relevant features of MvM are:

a. Reduced number of components: MvM consists of electro-mechanical valves, a medical care flowmeter for direct regulation of the maximum flow rate, an oxygen therapy humidifier, pressure and oxygen sensors, manual valves and medical hoses. A VDC battery provides the backup power supply for the control system;

b. Ease of supply: the parts required for the construction of MvM have been selected from those available in many nations. The selected parts are also characterized by the ease of use in the production and assembly of the device on a large scale;

c. Constructive simplicity: the assembly of the parts in a complete MvM will be feasible based on a small set of clear instructions. The software is open-source and available for customization by end-users;

d. Cost containment: the preliminary estimate of the total cost of the components is encouraging compared to the market price of this kind of devices;

e. Easy installation: the device only requires connections to a pressurized oxygen line and power supply Standard AC (220 v or 110 v); this feature allows its use in clinics with centralized oxygen and air supply systems (Covid-19 hospitals or Covid-19 care areas in general hospitals), but also for home care and use in ambulances;

f. Customization: thanks to the development of specific algorithms, the MvM can operate in different ventilation modes: independent and patient assisted. The operator›s operating parameters can be adjusted through a simple user interface; besides, the software will be implemented to increase the versatility of the graphic interface and offer customizable settings to the individual patient, with the possibility of remote control of the device parameters.

g. Reliability: the MvM is designed to be easily repairable, replacing individual parts that may not work;

h. Limited oxygen consumption: oxygen consumption with this device will not exceed 6LPM.

The final result of the project will be the availability of a certified ventilator ready for mass production in a short time. The characteristics will also be defined on the basis of clinical experience with the available prototypes and to create a machine that can follow the care of the Covid-19 patient from the first to the last day of hospitalization.

The example of MvM underlines the strategic role of fundamental research and how it provided a concrete contribution to tackling this emergency in a very short time.

At crucial moments, thanks also to the researchers (many of whom are women), who study the physics of astroparticles and elementary particles, both the knowledge and the technological infrastructure of research institutions and universities have been made available to the country.

In addition to MvM, several initiatives have been developed in recent weeks to fight the Covid-19. At INFN, the CNAF has made computing and data-storage power available for studies dedicated to developing new drugs and understanding the mechanisms of the formation of proteins linked to the spread of infections. A working group is carrying out the statistical analysis of pandemic data on a daily basis.

At the same time, at LNS (National Laboratories of the South), in collaboration with the University of Catania, new laboratories have been set up to verify the functional qualities of tissues for the production of masks to prevent the infection.

In this dramatic context, the positive impact on the society of the investments in the research sector is once again evident; we hope that this crucial role will be taken into account by the governments in the post-Covid phase.

Eugenio Scapparone started his research activity at the end of the '80s, joining the MACRO experiment at INFN Laboratori Nazionali del Gran Sasso (LNGS), led by B. Barish. Later he moved to INFN-Bologna to join the construction of the ALICE Time of Flight detector. In 2008 he spent one year at CERN as Scientific Associate, to serve as ALICE Deputy Commissioning Coordinator and as member of the ALICE Technical Board. In the next years he was member of the ALICE Physics Board, convener of the ALICE "Forward Physics" Working Group (2012-2014) and of the "Minimum Bias" Physics Working Group (2016-2017).

In 2016 he joined the DarkSide Collaboration, serving as "Photo-electronics" L1 manager and later as Project Leader (2018-2019). In 2019 he was elected member of the Council of the European Physical Society Council. In 2020 he was appointed as Director of the INFN-Bologna, with 120 employees and about 200 associates.

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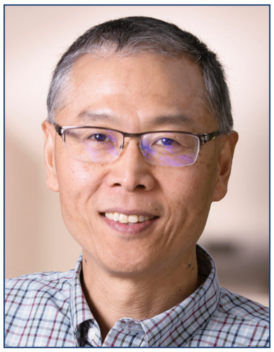
1.] *Mechanical Ventilator Milano (MVM): A Novel Mechanical Ventilator Designed for Mass Scale Production in Response to the COVID-19 Pandemic*, C. Galbiati et al., arXiv:2003.10405

Entangled Worldlines: Four Physicists Whose Transnational Trajectories Reshaped Physics and Diplomacy in China and the United States

Zuoyue Wang



In their thoughtful 2019 report on "Openness, Security, and APS Activities to Help Maintain the Balance," members of the American Physical Society presidential line recounted a recent listening tour at several federal agencies to hear their concerns over risks from international scientific exchanges, especially those with China. In their analysis, the APS leaders pointed out that while there were real threats, overreactions could "endanger US physics, which relies upon international participation in research." In this essay, based on a talk at the March 2019 APS meeting in Boston, co-sponsored by the Forum on International Physics and the Forum on the History of Physics, I would like to argue that from a historical perspective, US-China scientific exchange and mobility contributed not only to scientific development in each country but also to solving global problems such as the nuclear arms race and proliferation.

At the center of the story were four American-educated Chinese physicists whose worldlines were entangled with each other and with national and international politics in China and the US: DENG Jiaxian (1924-1986), Tsung Dao LEE (1926-), Chen Ning YANG (1922-), and ZHU Guangya (1924-2011) (family names in all caps). Compared to Lee and Yang, who are well-known to APS members as the Nobel physics laureates in 1957 and long-time leading American physicists, Deng and Zhu are less well-known in the US, but they are pivotal figures in the development of the Chinese nuclear program.

How did their trajectories first intersect? Both Yang and Deng's fathers were professors at Tsinghua University in Beijing in the 1930s, so they got to know each other well in their childhood. Both also went to Kunming to study physics at the famed wartime Southwestern Associated University, which was formed in 1937 based on Tsinghua, Peking, and Nankai Universities, then in exile from the Japanese invasion. It was also there that they met Lee and Zhu as fellow students in physics.

In 1945, Yang was the first in this cohort to leave China for the US, eventually settling down at the University of Chicago to work for his PhD in physics. The next year Lee and Zhu followed suit, having been sent by the then Nationalist Chinese government to the US as part of a scientific mission to learn to make atomic bombs. Lee and Zhu bonded with each other both before the trip, in a small physics seminar given by their (and Yang's) professor Wu Dayou (Ta-You Wu), who was the leading physicist of the mission, and during the long voyage across the Pacific. Arriving in the US, members of the mission quickly realized that US national security restrictions would not allow them to fulfill their purpose; they dispersed into American universities to pursue non-classified research and graduate studies. Lee joined Yang at Chicago, while Zhu entered the University of Michigan to work for a PhD in nuclear physics. In 1948, Deng also entered the US, pursuing a PhD at Purdue University.

Surviving photographs indicate that Deng and Zhu separately interacted with Lee and Yang but probably not each other in this period in the US, although both were active in the Chinese Association of Scientific Workers in the USA, which was influenced by the Chinese Communist Party. Yang was also listed in the association's membership (Lee was not) but he did not recall participating in any of its activities.

In 1950, when Zhu and Deng received their PhDs they both decided to quickly return home to the newly established People's Republic of China. Many others with similar intentions were not so lucky as the US dramatically restricted their exits between 1951, in the shadow of the Korea War, and 1954-1955, when the US and China negotiated in Geneva to allow exits of those students who still wanted to return to China in exchange for China-held US prisoners of war. Back in China, Deng conducted research in the Chinese Academy of Sciences while Zhu taught physics at Peking and the Jilin Universities. They would work closely with each other in the late 1950s when both were assigned to work on the Chinese nuclear weapons project. Deng was put in charge of the theoretical division, and Zhu became the enterprise's overall technical organizer. Meanwhile, Lee and Yang decided to stay in the US and collaborated fruitfully on a number of research projects, including the non-conservation of parity in weak nuclear interactions that would win them the Nobel prize in 1957. Personal frictions, however, led to an end of their celebrated partnership in 1962.

The decades-long separation between Deng and Zhu, on the Chinese side, and Lee and Yang, on the American side, was finally broken in the early 1970s when the reopening of US-China relations under President Richard Nixon made it possible for first Yang and then Lee to make visits to China. Yang's request to meet with Deng in 1971 in Beijing apparently helped alleviate political pressure on the latter during the still ongoing Cultural Revolution attacks on elite scientists (the initial protection for those engaged in secret projects had weakened by then). Upon his return to the US, Yang debriefed and received personal encouragement from Edward David Jr., Nixon's science adviser. When Lee landed in Beijing in 1972, Zhu was among those to meet him at the airport. Two years later, Zhu would accompany Lee to meet with the Chinese leader Mao Zedong. During these visits in China in the late Mao years, both Yang and Lee used their prominence as Nobel laurates to advocate for the legitimacy and support of scientific research and education.

In the late 1970s, with Mao's death, the end of the Cultural Revolution, the launching of the Chinese reform drive, and the formal establishment of US-PRC diplomatic relations, Lee, Yang, and many other Chinese American scientists, including Chien Shiung Wu, APS president in 1975-1976, began to participate more actively than ever before in promoting scientific research and education in China as well as US-China exchanges in these areas. For example, Lee spearheaded the influential CUSPEA (China-United States Physics

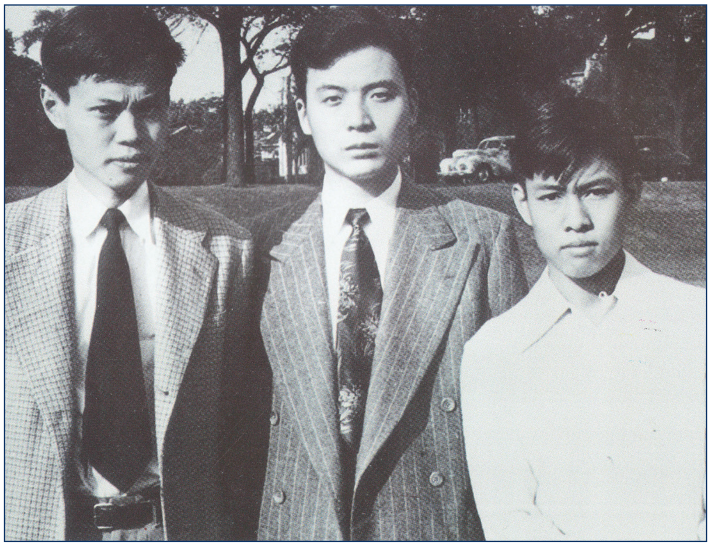


Figure 1. C. N. Yang, Deng Jiaxian, and C. P. Yang (C. N. Yang's younger brother) in Chicago in 1949. Courtesy of Professor C. N. Yang

Examination and Application) Program in 1979, which in the ensuing decade, brought about one thousand bright students from China to the US to pursue graduate studies in physics.

Once the CUSPEA students finished their studies, some of them went back to China. Still, a majority have, like Lee and Yang in the 1950s, chosen to stay in the US and become an important part of the American physics community or branched out into other endeavors. Benefiting in part from the excellent reputation of the CUSPEA program, hundreds of thousands of other Chinese students (including Deng's daughter Diandian), mostly in science and engineering, have come to the US to pursue graduate studies in the last four decades. A majority of these students have decided to stay after completing their studies and have become a key part of the American scientific, technological, and educational workforce.

In the 1980s, Lee also played a key role in official US-China scientific collaboration in high energy physics, especially the design and building of the Beijing Electron-Positron Collider (BEPC). Since BEPC was largely inspired by machines at the Stanford Linear Accelerator Center (SLAC), Lee helped convince Wolfgang "Pief" Panofsky, his close friend and founding director of SLAC, to serve as the official American advisor to the Chinese government on the project in Beijing. For his tireless efforts to make the BEPC a Chinese and international scientific success, Panofsky earned widespread respect and admiration in China.

Perhaps unexpectedly, Lee and Panofsky's active involvement in the BEPC also led to a remarkable episode in US-China scientific diplomacy that brought Lee, Zhu, and Panofsky together in the promotion of international nuclear arms control. These events took place against a geopolitical background in the mid-1980s when President Ronald Reagan departed from his initial hardline position on the Soviet Union and started to negotiate with the reformist Soviet leader Mikhail Gorbachev to reduce each other's nuclear arsenal. Panofsky, a long-time advocate on nuclear arms control and then chair of the Committee on International Security and Arms Control (CISAC) of the US National Academy of Sciences, sought to capitalize on his reputation and connections in China to bring Chinese scientists into the bilateral discussion on this subject with his committee. He did so with the knowledge and approval of the US government. Everyone recognized that if the US and the Soviet Union were to reduce the sizes of their nuclear forces dramatically, it was necessary to bring other nuclear powers such as China into the discussion.

In Beijing, Panofsky quickly found out that his regular host, the Chinese Academy of Sciences, as a largely civilian entity, was not the proper partner for an effective and continuing dialog on nuclear arms control. The institution he needed to have access to was the Chinese Commission on Science, Technology, and Industry for National Defense (COSTIND). The person he wanted to talk

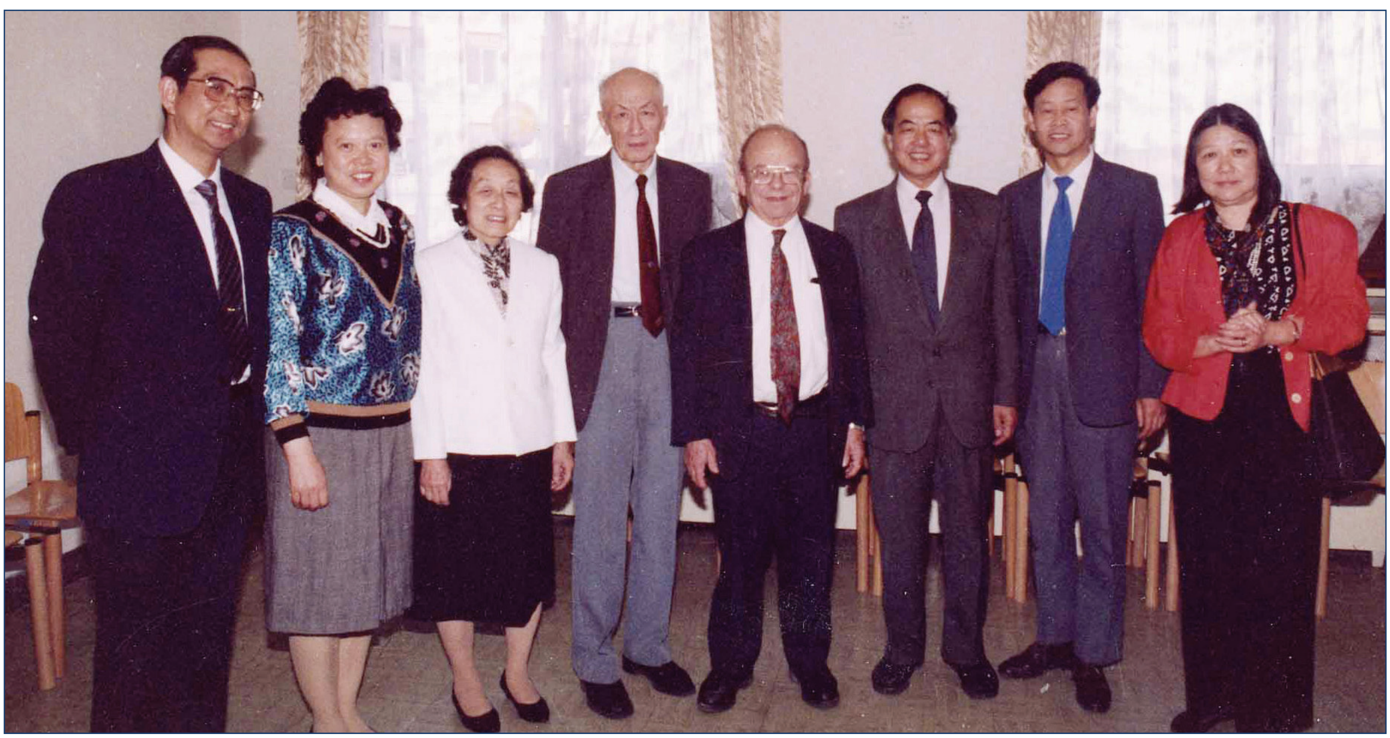


Figure 2. Zhu Guangya (4th from left), Wolfgang "Pief" Panofsky (5th from left), T. D. Lee (6th from left), and Jeanette Lee (far right) in Beijing in June 1992. Source: Courtesy of the Panofsky family and SLAC Archives.

to was nonother than Zhu himself, at the time the vice chairman of the Scientific and Technological Committee of COSTIND. He had invited Zhu for the first preliminary meeting on the topic, held at the Institute of High Energy Physics (IHEP), the institutional home of BEPC, in Beijing, on May 23, 1988, but Zhu did not show up. Even though the meeting, attended by other leading Chinese nuclear weapons scientists, was fruitful, Panofsky was uncertain at its end that his main objective of establishing a regular program of US-China scientific discussion on nuclear arms control was attainable.

At this critical moment, as I have recounted in a recent article ("Controlled Exchanges" in *How Knowledge Moves* edited by John Krige and published by the University of Chicago Press in 2019), Lee came to Panofsky's rescue. Lee had supported the cause of nuclear arms control back in 1963 when he lent his name to a statement by a number of Nobel laureates endorsing the Limited Nuclear Test Ban Treaty. The treaty had been negotiated between the US, the Soviet Union, and Britain, a process in which Panofsky had participated in as a member of the US President›s Science Advisory Committee (PSAC), and was then being debated in the US Senate as a part of the ratification process (it passed). Lee now returned to the endeavor by helping Panofsky to become connected with Zhu. As Panofsky wrote happily in his diary the night after his preliminary meeting at the IHEP, "T. D. Lee arranged for me to have lunch tomorrow with Zhu Guangya, who is really the key person to make the decision on the future of arms control discussions."

So, on May 24, 1988, with Lee and his wife Jeannette present, Panofsky met Zhu for lunch in Beijing. Once again, Panofsky recounted with delight in his diary that night his first encounter with Zhu and their informal discussion on nuclear arms control: "Zhu pointed out that there was some 'political sensitivity' in setting up a similar committee of scientists in China but the conversation ended by [Zhu's] saying 'I will do my best.' Nothing better could be expected at this point."

What we learned many years later, from Chinese sources, was that Lee not only set up this crucial meeting between Panofsky and Zhu but also mobilized his own scientific and political capital in China to help make it possible for Zhu to lead the Chinese efforts in arms control discussion with the US. For example, he wrote a letter to Marshal NIE Rongzhen, the chief organizer of the Chinese nuclear weapons program still influential in Chinese policy-making, to vouch for Panofsky's goodwill in his scientific and arms control activities in China and to request permission for Zhu to engage in dialogs with Panofsky. It is not definite but possible that this letter contributed to convincing the Chinese government to approve Zhu's proposal to set up the Chinese Scientists' Group on Arms Control (CSGAC), which has held continued discussions with CISAC nuclear arms control. Both Panofsky and Richard Garwin, the longest-serving member of CISAC, believed that the CISAC-CSGAC dialogs contributed to China's involvement in nuclear arms control, including in the area of nuclear nonproliferation.

What can we draw from this brief examination of the complex and intersecting experiences of these Chinese and American physicists? Historically speaking, one conclusion is that overall US-China geopolitical relations have always framed bilateral scientific interactions and affected the experiences of Chinese American scientists like Lee and Yang. At the height of US-China tension in the 1950s, Deng, Zhu, Lee, and Yang all had to make fateful choices to either return home or stay in the US, understanding that such decisions could separate them from their families or each other for the foreseeable future. In the late 20th century, as US-China relations reopened and improved, they participated in promoting bilateral scientific exchanges, even in sensitive areas such as nuclear arms control, as demonstrated by the active roles of Panofsky, Lee, and Zhu in initiating the CISAC-CSGAC dialogs.

In recent decades, close ties have developed between the US and China in many fields but the latter's rise as an economic and technological power has led to increased frictions. Yet, it is precisely at difficult times like this that we need to remind ourselves of the long-term benefits of open scientific exchanges, of attracting international talents like Lee and Yang, and of upholding American principles of justice, including equal protection, due process, and nondiscrimination regarding national origins. What is potentially at stake is not only the vitality of the American scientific enterprise, as the APS leaders rightly pointed out, but also the solution of global problems such as the nuclear threat and climate change.

Zuoyue Wang is a professor of history at the California State Polytechnic University, Pomona. He is the author of In Sputnik's Shadow: The President's Science Advisory Committee and Cold War America *and is now working on a book on Chinese American scientists and US-China relations. He was elected a fellow of the American Association for the Advancement of Science in 2019.*

Physics and Politics Intertwined: A Critical Review of the 2016 Great-Collider Debate in China

Tian Yu Cao

Late in the summer of 2016, a long-simmering dispute in the Chinese scientific community and the general public over China's desirability of devoting significant resources to ambitious high-energy accelerator projects boiled up and out in the press and on the internet.[1] The debate had two dimensions, scientific and political, and the two dimensions were inseparably intertwined.

The author of this account of that debate was himself a participant in it, and thus this account, while intending to be informative and fair, does not seek to be neutral.[2]

Members of the APS Forum on International Physics know well the leading roles played by the Chinese-American high-energy theorists C.N. Yang and T.D. Lee in fostering substantial personal, institutional, and political relations with China starting even somewhat before US President Nixon's visit to China in February 1972. They probably also know that these two physicists, close collaborators in the 1950s, had by the late 1970s quite different perspectives on many topics, including the priority China should give to accelerator-based high-energy physics.

By that time, C.N. Yang's standing in China, far outstripping that of T.D. Lee, was higher than that of any other scientist – so high that Deng Xiaoping came to C.N. Yang's Beijing hotel room in 1978 for their first meeting. But Deng was not persuaded by C.N. Yang's arguments against China undertaking to build the electron-positron collider advocated by T.D. Lee and other leading American particle physicists. That collider, the BEPC, completed in 1988, went through various upgrades in the following two decades, but by 2008 its inevitable shutdown had been set for 2022.

And that shutdown decision reopened the question of China's role in accelerator construction and experimentation – how modest or ambitious would it be?

The energetic director of the Institute of High Energy Physics of the Chinese Academy of Sciences, Wang Yifang (Y.F. Wang), projected the most ambitious thinkable successor to the BEPC. As the next big step in circular colliders beyond CERN's LHC, it was initially conceived as 54 km in circumference, i.e., twice that of the LHC, but in later versions, its circumference grew to 100 km. In 2012, following the discovery of the Higgs particle, the evolving plan was tailored as a Higgs factory, to be completed by 2022, producing a million Higgs particles by 2030. This Circular Electron Positron Collider (CEPC) was to be constructed in a tunnel of large enough cross-section to comfortably accommodate also an eventual proton collider ring (SppC) and the necessary roadway for service vehicles between the two accelerators. The estimated cost was 6 billion dollars for the tunnel and the CEPC, and two or three times that for the SppC.[3] As the Chinese government did not immediately commit – and has not yet committed – to the CEPC-SppC, the construction schedule necessarily slipped.

In 2016, when the debate broke out, CEPC construction was proposed to begin in 2021, with operation from 2028 to 2035, followed by the construction of the SppC.[4]

YF. Wang mounted a multi-pronged campaign to build scientific, financial, political, and public support for this initiative to make China the future center of high-energy physics. Leading figures in the US were recruited to advocate his program – Nima Arkani-Hamed, a professor in the Institute for Advanced Study, Princeton, was recruited to be the director of the IHEP's Center for Future High Energy Physics[5]; David Gross and Edward Witten repeatedly went to China as well as writing an op-ed in the *Wall Street Journal* in September 2015.[6] Timed to coincide with Xi Jinping's state visit to Washington, DC, this "pitch" by the Nobelist and the Fields Medalist carried considerable weight in China. YF. Wang himself (vainly) put a copy of the 2014 preliminary conceptual design report into the hands of C.N. Yang (who since 2005 had been living in China and who in 2015 showed his commitment to China by renouncing his US citizenship, reacquiring Chinese).

But Y.F.Wang's most prominent ally in this campaign was the Chinese-American mathematician and mathematical physicist Yau Shing-Tung (or Qiu Chengtong, as written in pinyin). A generation younger than C.N. Yang, Yau, by all the usual measures of scientific accomplishment and recognition, out-shines even Yang – and thus every other Chinese scientist.[7] Moreover, Yau is gregarious, his institutional involvements multifarious. In the autumn of 2015, he published, together with a US science writer, a book advocating the CEPC-SppC, with a Chinese edition appearing in spring 2016.[8] Yau and his co-author emphasized that CEPC "would transport physics into a previously inaccessible, high-energy realm where a host of new particles, and perhaps a sweeping new symmetry, might be found" and that it could add to knowledge about "the Big Bang, gravity, dark matter, dark energy, and other far-reaching phenomena."

On August 7, 2016, Xinhua published an interview with Yau promoting his book.

This interview drew some press criticism referring to C.N.Yang's opposition to expensive accelerator building. Yau, exasperated after years of having Yang's opposition rehearsed to him, responded on August 29 with a posting on the WeChat website "The Intellectuals"[9] expressing, in more than just a few words, his incomprehension that C.N. Yang turns his back on the science which his own contributions had advanced so importantly. To this, Yang replied a week later, quite impersonally, on the same website with a reiteration of his arguments against China devoting significant resources to building accelerators for elementary particle research. Undoubtedly his most wounding thrust was: "if this accelerator wins someone a Nobel Prize, will that person be Chinese?". YF. Wang responded the next day, and the debate then raged – without Yau or Yang saying anything further.[10]

The enthusiasm of high energy physicists for this project, especially if conceived as one funded by China but open to international participation, is obvious. On the one hand, the discovery of the Higgs at the LHC, while no hints of more or better than the Higgs – i.e., more or better than The Standard Model – had come to light, served only to increase their interest in going to substantially higher energies. On the other hand, from SSC to LHC and beyond, governments' support has been diminishing and increasingly uncertain as funding priority has shifted to other branches of science-technology, branches believed to have direct impacts on economic progress, or at least have noticeable impacts on neighboring research areas. Thus new sources of funding are desperately sought for more powerful colliders, which might offer a new direction for the further advancement of particle physics.

In China, the CEPC-SppC project was strongly supported by official institutions and public opinion – at least it was up to the autumn of 2016, when the debate broke out – for two reasons.

First, China's confidence in its scientific capabilities was consolidated by its experiences in collider physics (construction, technology, engineering, management and experiments) through the Beijing Electron Positron Collider (BEPC) project for more than three decades. The IHEP's more recent success, further boosted that confidence under Y.F. Wang's leadership, the observation of the oscillation of electron anti-neutrinos issuing from the Daya Bay reactor, a result obtained almost simultaneously with competing experiments in the west.[11]

Second, the deeper reason rooted in China's economic-political situation:

By riding the wave of globalization, which was made possible by US's strategic assistance, China's economy expanded rapidly. Within a few years of its WTO entry, it became the world's factory. In 2010 China overtook Japan as the world's second-largest economy. In 2011 China's manufacturing output surpassed that of the US to become the world's number one goods producer. However, China's impressive rise to global economic power was not driven by technological innovation. Instead, it was heavily dependent on the export of low-skill products, which is to say on low wages; This rendered China not merely vulnerable to global market fluctuations and foreign manipulations but was inherently unsustainable: rising wealth entailed rising wages for Chinese workers. Thus, China would eventually price itself out of the low-skill export market. This prospect led China's leadership to launch in 2006 the indigenous innovation program, and in 2012 it put forward the "innovation-driven development strategy," aiming at cutting down the technology dependency ratio below 20% by 2020. (The foreign control of China's high-tech industry had reached 70% in 2009.) And in 2015, China's leadership announced the "Made in China 2025" plan.

The technological situation was not easy to change.

Putting aside the rampant corruption in the science community, China lacked the absorptive capacity crucial for assimilation and innovation, due to its acute under-investment in technology education. But China's leadership believes that it has a magic key, namely big state-owned enterprises (SOEs). It believes that big SOEs embody the crucial organizational advantage China's system enjoys over the west: SOEs can pool all needed resources to address significant issues or carry out grand projects such as the A-bomb, the H-bomb, rocket, missile, and satellite projects, and did so even under the economically extremely backward conditions in the 1950s to 1970s.

Since 2006, big SOE's technological capabilities have increased significantly. They have given China notable technological achievements in many areas, including supercomputing, lunar exploration, high-speed trains, petrochemicals, nuclear technology, and high voltage electrical transmission. Not only did China begin to export home-made high-tech products in the global market, but instead of holding to its earlier practice of sitting on an ever-growing pile of foreign currency, China became the world's largest exporter of capital with its outbound foreign investment supporting and being supported by the party-state's increasingly proactive and assertive diplomacy, "The Great Power Diplomacy."

Emerging together with these developments is the Communist Party's call for realizing "The Chinese Dream of the Great Rejuvenation of the Chinese Nation." An important component of this mission, the Central Committee decreed in 2015, is to "deeply implement the innovation driving development strategy, give rein to the guiding role of scientific and technological innovation in comprehensive innovation, implement a batch of major national science and technology programs, build a batch of national laboratories in the area of major innovation, [and to] ***vigorously put forward and take the lead in organizing international big science plans and big scientific projects***.[12] This was quickly followed by President Xi's offering the world "the Chinese wisdom and a Chinese approach to solving the problems of mankind"[13], thus openly challenging the US as the new global hegemon.

It is in this context that the importance of the Gross-Witten *WSJ* commentary and its powerful appeal in China are to be understood, that is, by its combining their presumptively authoritative judgment of the CEPC-SppC's scientific importance with an acknowledgment of the validity of the perspective being pushed by China's leadership: "With China emerging as a superpower in its own right, U.S.-Chinese collaboration on the Great Collider could play a similar role" CERN played in the cold war era in dampening "the dangerous tensions between the two superpowers". In official media (through articles, interviews, conference reports, news coverage, etc.), the project was universally praised and hailed as a sure indication that China is taking global leadership in HEP and sci-tech generally.

In social media, it was more controversial, and in private conversations among scientists, including physicists in branches other than HEP, complaints and criticisms were frequently heard. But not until September 2016 were these dissenting voices heard loudly and widely in both social media and the press.

The "single voice" situation began to change and the real debate started September 4 when C. N. Yang published his firm opposition to the project online. Yang was old (then 94), his article was short, but his opposition was clear and devastating:

1. Its scientific value (the selling point for string theorists Gross and Witten and string-related mathematician Yau) presupposed that there were particles, and specifically super-symmetric particles, waiting to be discovered. Since the very existence of such particles was only a conjecture, supposing that the great collider would be capable of discovering them was only piling "conjecture upon conjecture."
2. Its cost (at least $20 billion) is too much for a developing country like China, with hundreds of millions of peasants and migrant workers. Numerous extremely urgent social issues in

health-care, education and environmental protection and restoration have to be addressed. Moreover, such huge expenditure in this direction "would inevitably exclude funding necessary for other fundamental science, including life sciences, condensed matter physics, astrophysics, etc."

3. It would deliver no benefits to human life within the next three to five decades, even if it is successfully carried out and pushes HEP one great step ahead.
4. The design, operation, analysis and interpretation would necessarily be guided and controlled by foreign scholars, who would consequently be awarded the Nobel Prizes.

Yang is an internationally recognized grandmaster of theoretical physics. In China, he is a national hero. Thus his opinion carried a super-heavyweight, and its public expression opened a channel for vocalization by the repressed opposition. Recognizing this danger, YF. Wang responded online the next day, arguing combatively:

1. Concerning the scientific value of the collider, Wang contradicted Yang's stigmatizing it as merely conjectural by stressing that the project has two phases, and the first, CEPC, phase (Higgs factory, precise measurements) is realistic and is an unavoidable step in advancing HEP. Only the second, SppC, phase, which tests the SM, and goes beyond the SM (which can, in any case, be only an effective theory) to discover new physics, is conjectural.
2. Concerning costs and benefits, Wang stressed: (1) "China now is very rich, but too pragmatic to make contributions to human civilization, and thus is unable to have soft power and exert influence. In return, this has negative effects on China's ability to obtain its interests in the world." (2) The project "will enable China to lead the world in HEP for decades." (3) As for its impact on other fundamental sciences, Wang stressed that the project is the best candidate for answering the party's call: "vigorously put forward and take the lead in organizing international big science plans and big scientific projects."
3. Wang bluntly challenged Yang's authority, criticizing Yang's views on HEP as being pessimistic, dogmatic, and out of the mainstream in the international HEP community – with the result that Yang had missed the opportunity to contribute to the SM. Wang repeatedly mentioned "many HEP Nobel laureates" and "the Directors of the main National Laboratories globally" as his backers. He also urged that the political leaders should listen to scientists of his generation who were necessarily the only candidates for sci-tech leadership, domestically and globally.
4. Wang cited Deng's ignoring Yang's objection to the BEPC project, thus strongly suggesting that political leaders should follow Deng's example and ignore Yang's objections to this collider project as well.

While Wang's online rebuttal was the subject of heated discussion, likewise online, it was almost three weeks before a reply to Yang's critique appeared in the official press. On September 23, the Xinhua *Daily Telegraph*, China's official news medium, published Gross's vehement, point-by-point contradiction of Yang: "no", "no", "no", "I strongly disagree," "I am shocked," and similar expressions alternating with statements of the strongest possible support for the project: "A golden opportunity for China to be a world leader of fundamental physics at one stroke"; CEPC "will advance the development of science, become a magnet to attract talents in physics and engineering globally", and "help to lift China to be an economic superpower".

Shortly after C.N.Yang's critique had been posted, on September 6, the Beijing office of MIT's *Technology Review* approached the author of this article, widely known in China as a historian and philosopher of HEP, requesting my commentary on the debate. I welcomed this opportunity to describe the controversy and my position on it. But when my commentary was delivered, the journal declined to publish it, finding it too negative toward the collider project. My commentary then appeared on the Wen.org.cn website on September 27[14] and is reprinted in the World Scientific volume cited in note 9. Its major points are:

1. Anti-reductionism: In line with P. W. Anderson's view, HEP is too fundamental, that is, to fundamental to be relevant to other branches of fundamental science.
2. A theory-led view of scientific development: a 'Higgs factory' enabling precise measurements of Standard Model entities and processes will not give clues to new physics without a clear theoretical formulation. Thus any claim of knowing the secret of the universe from experiments without a clearly formulated theoretical understanding could not be more than empty words.
3. Nobelist S. L. Glashow supports Yang's position: HEP can have no practical utility, it extracts (rather than adds) economic resources. The reason: it investigates not the things existing in the world, but the things we create at considerable cost.
4. These "things" – the tau, W, K, etc. particles – are all too short-lived to have any practical utility.
5. Decision making should not be manipulated and monopolized by social groups with vested interests. Society as a whole, rather than a few experimental experts, should have the final say on how to spend huge amounts of money ($21 billion) squeezed out from hundreds of millions of migrant workers who live under miserable conditions.

Nor was the author of this commentary (and of the present article) the only writer to appeal in this debate to Nobelist Philip W. Anderson's arguments against large expenditures for particle accelerators.

Those arguments, most pertinently expressed in testimony to the US House of Representatives in opposition to the SSC[15], were often cited and quoted by opponents of the CEPC-SppC, and were included in the World Scientific volume cited in note 9.

Most important among them are:

1. The rejection of "the myths supporting the unique value of elementary particle physics" showcased his antireductionism. Anderson argued that "science can be fundamental without being irrelevant", but particle physics "has become so "fundamental" as to be almost totally irrelevant, even to the rest of science," "nothing high energy physics can do will ever be of the slightest direct help in solving these overwhelmingly hard problems" such as "what drives the new high-temperature superconductors, or what makes a snowflake, or how the mind or the economy works." Anderson provocatively asserts: "If the particle physicists tell you they will understand even the Big Bang better as a consequence of the SSC, they are being wildly optimistic; and if they claim any other relevance, they are wrong".

On June 24, 2012, Professor Cao Tianyu was invited to give a talk at the 40th Anniversary Celebration of the Advent of Quantum Chromodynamics at The International School of Sub-nuclear Physics in Erice, Sicily, Italy. After the special lecture of "Key Steps Toward the Creation of QCD", before the singing and dancing performance dinner, a photo with Murry Gell-Mann, the main founder of QCD.

2. Practical arguments similar to those that Yang raised in his opposition: experimental HEP "competes for resources which I see as needed more elsewhere." This is particularly worrisome because HEP's large facilities "are not places where you discover breakthroughs … Rather, they are places in which you test breakthroughs once you have them." In contrast, small group work is the most innovative, and "must not be cut back in favor of the large facilities." Besides, there are other urgent scientific needs —in space science and, very importantly, science education.

Also introduced into the debate, and quoted in the World Scientific collection, are the comments made by Jonathan Katz of Washington University in St. Louis in a letter to the *WSJ* in response to Gross and Witten's September 2015 commentary. More radical than Anderson, Katz, an accomplished theorist – with a well-deserved reputation as outspoken contrarian – called particle physics "moribund," a "dying" branch of science, and declared that "The future of physics lies in such fields as atomic and condensed-matter physics. There, tabletop experiments of exquisite subtlety, with budgets in the hundreds of thousands, not tens of billions, promise (and have delivered) not only conceptual advances such as a deeper understanding of the fundamentals of quantum mechanics but also the possibility of technological breakthroughs such as quantum computing."

Mao's "Great Leap Forward" starved tens of millions. This "Great Scientific Leap Forward" promises to starve scientific progress.

Let hundreds of flowers bloom in laboratories around the world!"[16]

Negative comments were also posted anonymously to The-Intellectual web-journal by a highly regarded Chinese Academician whose identity many could guess:

1. The scientific objectives of the CEPC-SppC are not clearly defined: "when a scientific project is dubious, is it worth expending a huge amount of material and financial resources? The answer is negative".
2. Many key technologies are controlled by the west without which many technical details cannot be completed by China alone.

Wu Weimin – who had been involved with China's BEPC, the LHC, and many other projects – advised the enthusiasts for the Great Collider to be realistic.

Regarding scientific capability, he reminded them that there is an ocean of difference between those at the low level of BEPC and high level required for CEPC; china's assumed financial might is not decisive for the transition from the former to the latter.

More shrewdly, Wu stressed that international cooperation is the lifeline of HEP machines such as LHC and CEPC and of the multi-thousand-physicist collaborations that create and carry out the experiments at them. Thus a project like CEPC would be impossible without the active participation and cooperation of the US government; the participation of individual US scientists and individual universities is insufficient; it has to be at the governmental level. But the precondition for this is that the US and China have mutual strategic trust, have established a strategic partnership. Since at present, this is not the case, the project has to wait for a proper time in the future.

To fully understand the debating style and strategies on the 'favored' side in the collider controversy, i.e., the institutional establishment side, one must understand the political culture of decision making in China. The party leadership takes as their top priority in selecting projects the symbolic value of the project as illustrating the superi-

Higgs and Cao at the 40th anniversary celebration.

ority of the Chinese system, and specifically its unique capability of pooling all needed resources to carry out grandiose projects. Other merits of the competing projects are secondary. The symbolic is inevitably political and thus is more important than the scientific.

Even so, under increasingly fierce international competition, pragmatism is gradually becoming more important in resource allocation, as exemplified by China's very large investments in artificial intelligence, 5G, genetic engineering, and other innovative projects that are crucial for competition on the global stage.

Y.F.Wang's argumentation exemplifies this long-standing (but increasingly challenged) primacy of the symbolic in an email interview by the editors of "The Intellectual" website published online on October 20. There Wang, taking CEPC's unique and far-reaching contributions to China's soft power as well as its hard power as axiomatic, declared that "the leaders of our country have to make a political decision, whether to support it or not: if you want China to be a second class country, you can ignore it; but if you want to China to be a first-class country, then you have to support it." The published version of this interview had as title "Wang's further comments on the big collider: a political decision to make China world number one." Wang was embarrassed by the forthrightness of the title that the editors gave his responses, but his answers display very clearly the political character of his side of the debate, leaving China's leaders without space for deliberation: you have to support the project, otherwise, you will be blamed for blocking China's path to become a first-class country.

Y.F. Wang's vehement defense of the project was supported in an article signed by a group of 33 Chinese HEP physicists working in the US. Although this article, published on a website, is largely a tutorial on HEP, woven through it, is much the same presupposition and argumentation that appeared in concentrated form in Wang's October 20 interview and in the Gross and Witten 2015 *WSJ* commentary. Among these the most important was reductionism: the project›s importance and the value was dramatically exaggerated through an implicit line of reductive reasoning more familiar as "for want of a nail, the kingdom was lost": the CEPC's promised achievements are indispensable to the progress of high energy physics (HEP); the achievements of HEP are essential to fundamental physics (FP) generally; FP to fundamental science (FS); FS to science and technology (S&T); and, ultimately, S&T to the economy, culture and civilization. These radical reductionist claims were advanced through exaggerating the existent (but non-reducible) connections between neighboring areas, and ignoring the non-transitive nature of these non-reducible connections: the connections get feebler when they involve non-adjacent areas.

Second, like Y.F. Wang's interventions, the article by 'the 33' fails to distinguish between reasonable national aspirations and national' dreams of glory'. It conflates (i) emergence from economic backwardness and a condition of national humiliation, having a favorable image and positive reputation in the world, being confident of the capability of doing whatever other nations can do, or even cannot do, and many other similar aspirations that should speak to the hearts of the general public, and (ii) the unreasonable, immature, and even dangerous ambition to be a Great Power and achieve world leadership as hegemon, offering the world not only "the Chinese Model" but also "the Chinese wisdom and a Chinese approach to solving the problems of mankind." This latter form of "the Chinese Dream", with the "China miracle" in its economic performance, has been on the rise, indeed in high fever in some circles since 2013, along with policies promoting "Great Power Diplomacy", as manifested in establishing Confucius Institutes worldwide, hosting numerous international conferences, trying to establish a G2 world order, etc.

Carrying this conflation into the field of particle physics research, 'the 33' present the CEPC-SppC as the culmination of a world-historical migration of pre-eminence in HEP from the US's failed SSC to Europe's successful LHC to China's emergence as the world's fundamental research center. China, they say, was defeated and humiliated by the west mainly because of its lack of curiosity-based abstract science and science-based technology, and the CEPC-SppC will show that with the rise of China's economic power and the decline of the US, China now can do what the US and the west, in general, cannot do: stand at the apex of fundamental science. So the Chinese people can be proud of catching-up and surpassing the west in the area characterizing modern civilization.

Indeed, 'the 33' contend that the CEPC can make crucial contributions to China's Great Power ambitions. They argued that as an aspiring Great Power, China should not be content with its economic might, and has to take the leadership of human civilization in the forthcoming era, the era defined by ever-renewed science and high-tech, whose foundation is HEP. This leadership has to be embodied in grand projects – the Central Committee's 2015 call for leadership in such international projects was often cited – and the CEPC is an ideal example of such. Its construction, hosted, financed, and controlled by China, will enable China to become, at one stroke, the world center and the world leader in HEP for decades to come. Such an achievement, of which the US is incapable, will greatly increase China's self-confidence, improve its image, and expand its influence. It will massively enhance China's soft power with a more attractive sci-tech diplomacy based on CEPC.

It was further argued that CEPC will also be crucial for the development of China's hard power. As the world's center of HEP, which is the crown jewel of fundamental science, it will function as a magnet to attract China science and high-tech talents from all over the world. This international collaborative project will also make it possible for China to acquire the most advanced technologies from participating western countries. Only with the talents and technology acquired through CEPC will China be able to transform its economy from an export-oriented, manufacturing economy relying on cheap labor, resource extraction, and environmental destruction into a (sci-tech) innovation-driven economy. Thus CEPC has to be recognized and appreciated as the major pillar in China's social and economic development.

To these often-heard contentions, implicitly framed within 5000 years of Chinese history, 'the 33' added the urgency of a (favorable) decision in light of the geopolitics of forefront accelerator construction. CERN, they argued, is at present fully occupied with upgrades to the LHC; the US focuses on neutrino experiments and supporting the LHC. Thus China has to seize this rare moment in time, this golden opportunity which may last only for 10-15 years. Moreover, they pointed out, pressing even more strongly for quick action is the prospect of US and European support consolidating around the International Linear Collider, proposed to be constructed in Japan with research objectives and projected construction period similar to those of the CEPC. Since such forefront HEP accelerator projects are necessarily transnational in the financial and personnel resources recruited for them, a commitment by the US and Europe to support one will inevitably preclude a commitment to support a second. Consequently, the CEPC is in direct competition with Japan's ILC, and China must act quickly.

In the three years since the intense phase of this debate, the Chinese government has 'slow-walked' the decision process. That unwillingness to make a commitment to achieving pre-eminence in HEP for China has pushed its HE physicists towards less nationalistic, more internationalist positions. Thus the document "The Planning of CEPC", prepared late in 2018, and posted on the CEPC website, sets out a genuinely international management structure while still anticipating that the call for proposals for those "China initiated international large science projects" envisaged by the Central Committee of the Party in 2015 would soon appear. However, judging from the CEPC website, that long-awaited call has still not been issued. Meanwhile, a series of "International Workshops" has been organized to promote the project as an international project. At the time of writing – mid-November 2019 – the third in that series of workshops is being held in Beijing (the two previous were held in Rome and Oxford): "One main purpose of the workshop is to make the CEPC study much more international by having broad participation and contributions globally, and to elevate the CEPC study group to an international organization."[17]

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[2] The author is grateful to Paul Forman for criticism and suggestions leading to a clearer account of this debate.

[3] A well-informed brief description of the project as it stood late in 2014 is given by Ernie Malamud, *The CEPC-SPPC Project, a Trip to China* , in the Spring 2015 issue of this Newsletter. aps.org/units/fip/newsletters/201502/china.cfm. A fuller description of the project as developed further in the following three years is given by Jie Gao, "China's bid for a circular electron-positron collider," *CERN Courier*, June 2018, pp. 21-25.

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[8] ST. Yau and S.Nadis, *From the Great Wall to the Great Collider: China and the Quest to Uncover the Inner Workings of the Universe* (International Press of Boston, October 23 2015). In an interview by J.N.A.Matthews for *Physics Today*, April 11 2016, Yau explained that: "I travel to Asia often. I helped establish six mathematics institutes (two in Beijing, one in Hangzhou, one in Hong Kong, and two in Taiwan), which I currently direct. I also started high school competitions in math and physics—perhaps soon to be followed by competitions in biology—all with the purpose of building up science throughout the region. When I heard about early plans for a new collider about five years ago, I naturally offered to help, talking up the idea with scientists I knew in China, the United States, and Europe. I also helped get proposals into the hands of influential decision-makers in China." physicstoday.scitation.org/do/10.1063/PT.5.3035/full/

[9] The-Intellectuals is a mobile media platform founded by three scholars, Rao Yi, Lu Bai, and Xie Yu in September 2015, which is dedicated to "discussions on science, humanities, and general ideas, for those who are eager for acquiring and sharing human knowledge, for independent thinking and analyzing modern ideas, and for building a China full of intelligence. It is very popular, not only among scientists and scholars but also among college students, and serves as an inclusive liberal platform".

[10] Three months after the publication of C.N.Yang's response to Yau, World Scientific, which publishes in Chinese as well as English, gathered some thirty items – most had appeared on the WeChat website "The Intellectual: – into a small volume: 中国超大型对撞机之讨论（卷一）潘国驹 何华 孙晗 主编 [*Deliberations on the super-great collider on China* vol.1,] World-Scientific, 2016; ISBN 9789813202085 (paperback); ISBN 9789813208995 (hardcover); ISBN 9789813206762 (e-book). The remainder of this article summarizes and quotes views presented there, including those of the author. "Deliberations" is not perfectly neutral: it leads off with C.N.Yang's response to Yau, but Yau's intemperate provocation is not included (and indeed now seems to be unfindable on the web). It also does not include the Gross & Witten *WSJ* 2015 op-ed. It includes a translation of ST. Corneliussen, "A 'Great Collider' in China," *Physics Today*, October 13 2015, physicstoday.scitation.org/do/10.1063/PT.5.8143/full/, who quotes the short letter by Jonathan I. Katz to the *WSJ*, Oct.3, 2015, savaging the Gross & Witten op-ed, and also includes a translation of Philip Anderson's "The Case Against the SSC" (1987), on which see note 15 below. World Scientific titled this "vol.1", promising to follow the ongoing debate and eventually publish a second volume.

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[12] Communiqué of the Fifth Plenary Meeting of the 18th Central Committee of the Chinese Communist Party, October 29, 2015. (Boldface added by the author for emphasis of the last clause.)

[13] Xi Jinping's speech on July 26, 2017: cpc.people.com.cn/xuexi/n1/2017/0815/c385474-29471759.html.

[14] wen.org.cn/modules/article/view.article.php/4259

[15] Published as "The Case Against the SSC" in *The Scientist*, June 1987: the-scientist.com/opinion-old/the-case-against-the-ssc-63734.

[16] wsj.com/articles/beware-of -those-chinese-great-leaps-in-science -1443813909.

[17] cepc.ihep.ac.cn/CEPC_Accelerator_Addendum/CEPC_Accelerator_Addendum.pdf. /indico.ihep.ac.cn/event/9960/material/1/0.pdf, p.3

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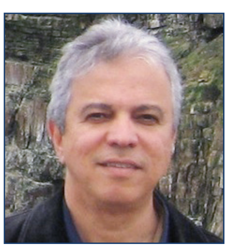

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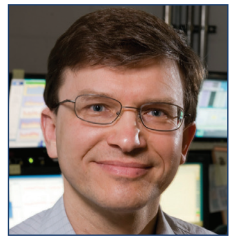

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