

Commentary

International Union of Pure and Applied Physics and you

As the International Union of Pure and Applied Physics (IUPAP) begins preparing to celebrate its upcoming 100th birthday in 2022, let's take a few minutes to reflect on the work the union is doing. It started out with 13 member countries and has grown to 60. It is now connected to many more countries and many more physicists. What does it do for them and for physics?

Our mission, as documented on our website, is "to assist in the worldwide development of physics, to foster international cooperation in physics, and to help in the application of physics toward solving problems of concern to humanity." We carry out that mission by sponsoring international meetings; fostering communications and publications; encouraging research and education; fostering the free circulation of scientists; promoting international agreements on symbols, units, and nomenclature; and cooperating with other organizations on disciplinary and interdisciplinary problems.

To readers of PHYSICS TODAY, IUPAP is perhaps best known through the international conferences it supports. Although IUPAP no longer provides more than a small fraction of the funds needed to run a conference, its support is important for two reasons—it aids conference organizers when they are seeking support from local funding agencies, and it verifies that the conference is a genuine

one. In these days of "fake news," we now have fake conferences. As an example, I invite you to google ICHEP 2016 and, separately, ICHEP 2017, and work out for yourself which is the genuine conference.

Since the start of the Cold War, fostering the free circulation of scientists has been a major concern of IUPAP. Early on, the main problem was getting Soviet physicists to conferences in the West. The first IUPAP general assemblies I attended were in 1993 and 1996, and some fellow attendees wondered, given

ment of working with people of many nationalities. Because the mix makes for better teaching and better research results, IUPAP will long continue its emphasis on upholding the free circulation of scientists.

If you read between the lines in the mission and action statements above, you'll also find that IUPAP promotes the role of physics in development. It created its Commission on Physics for Development in 1981. In 2005 IUPAP organized the World Conference on Physics and Sustainable Development in Durban,

South Africa, in association with its general assembly in Cape Town. The commission assists IUPAP in running at least three workshops a year in developing countries. IUPAP supported the African Institute for Mathematical Sciences in its early years and has consistently supported the Middle East synchrotron facility (SESAME). Sandro Scandolo, chair of our Commission on

Physics for Development, represented IUPAP at SESAME's official opening in May 2017 in Allan, Jordan. For the next three years the commission will be running the Lightsources for Africa, the Americas and Middle East Project (LAAMP) in collaboration with the International Union of Crystallography and with the support of the International Council for Science.

IUPAP's work on promoting physics and science for development will be a major part of its centenary celebrations, and the union will propose to UNESCO that 2022 be designated as the International Year for Basic Sciences in Development.

As I wrote this piece I became more and more aware that the mission and action statements, last ratified in 2002, are historical artifacts. They contain no explicit reference to physics for development, nor do they mention IUPAP's recent focus on increasing the fraction of women working in physics and improv-

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the collapse of the Soviet Union, whether IUPAP still had a role. They need not have been concerned. The union had been through one period of hard work to ensure that international scientists could come to the US, and we may well be entering another.

I find it strange that scientists should face restraints on international movement. I did my undergraduate and graduate studies at the University of Sydney, starting 60 years ago. The faculty came from a wonderful mix of countries—Australia, Great Britain, Canada, New Zealand, Switzerland, Germany, the US, and Pakistan. The university had immigrants and refugees from Europe and from the McCarthy-era US. One fellow student was from Trinidad, and one of my PhD supervisors was from Pakistan.

The mix of philosophies and attitudes made Sydney an exciting place for me. As a 1960s postdoc at the Institute for Advanced Study in Princeton, New Jersey, I again enjoyed the intellectual fer-

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ing their experience in the workplace. In that regard, we also need to make ourselves a better role model. For generations men have stewarded the union. In our 95 years we have had one woman, Judy Franz, as secretary general and one woman, Cecilia Jarlskog, as president. Both of those appointments were in this century, which an optimist can regard as a sign that IUPAP will have better gender balance in the future.

In 1999 we established the Working Group on Women in Physics. Although part of its mandate is to increase the participation of women in IUPAP activities, the fraction of women on our commissions remains well below the fraction of physicists who are women. A recent goal has been to have at least one woman on each commission. In October 2016 our executive council raised the bar, asking that at least four women serve on each commission in the 2018–20 triennium. I expect that will be difficult to achieve, and I hope I am proved wrong.

As previous presidents of IUPAP have proudly pointed out, IUPAP is a

volunteer organization, with one, or even no, staff. The business of IUPAP is done by its executive council (15 volunteers), its 18 commissions (252 volunteers), its 10 working groups (about 100 volunteers), and one staff member in the Singapore office. A great advantage of the arrangement is that decisions about IUPAP's activities are made by working physicists; the disadvantage is that the physicists must squeeze IUPAP tasks in around their day jobs. With our present budgetary constraints, it is not possible to increase our professional staff and our efficiency without cutting back on the support that we give to physicists. I hand the presidency of IUPAP on to Kennedy Reed on 13 October 2017 at the conclusion of our 29th general assembly. A major challenge for him will be to find ways to increase our resources and thus our impact.

More information about IUPAP is available on our website, iupap.org.

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LETTERS

Necessary and sufficient conditions for practical fusion power

The phrase “necessary but not sufficient” is often heard in technical disciplines. To generate electric power from nuclear fusion reactions, what's necessary is a reactor that can liberate much more energy than that required to heat and confine a plasma of fusion fuels. For decades, fusion energy research has focused mainly on the magnetic confinement of extremely hot plasma of fusion-fuel ions and electrons. Unfortunately, researchers have mostly ignored whether their schemes would be sufficiently practical.

In the early 1950s, when little was known about the physics of plasmas and plasma diagnostics were relatively few, several magnetic plasma-confinement concepts were conceived and experimentally pursued. All had challenges, and none emerged as a winner. Over the decades researchers meticulously devel-

oped the field, but a path to practical fusion power was elusive.¹

The situation seemed to change in the late 1960s, when researchers showed that the Russian tokamak concept for plasma confinement displayed promise. The toroidal tokamak magnetic confinement system uses deuterium and tritium to create fusion power. DT fuels require plasma temperatures on the order of a hundred million degrees. Reaction products include charged ions and copious neutrons.

Because of early tokamak success, fusion researchers worldwide dropped most other approaches and built tokamak experiments. In parallel, engineers designed fusion power plants based on tokamaks.

In the late 1980s, the idea of building a large, internationally managed and funded prototype tokamak experiment



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