Physics Today

From Beijing to Kigali, ICTP makes itself at home in the developing world

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Citation: Physics Today **67**(10), 20 (2014); doi: 10.1063/PT.3.2542
View online: http://dx.doi.org/10.1063/PT.3.2542
View Table of Contents: http://scitation.aip.org/content/aip/magazine/physicstoday/67/10?ver=pdfcov
Published by the AIP Publishing

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For 50 years the International Centre for Theoretical Physics has hosted scores of scientists and students at its campus in Trieste, Italy. It now hopes to replicate that model at regional partner institutions.

"It's almost like winning a lottery," says Venezuelan particle theorist Freddy Cachazo about the chance to study at the Abdus Salam International Centre for Theoretical Physics (ICTP). As an undergraduate physics student at Simón Bolívar University in Caracas, Cachazo knew he needed to leave his home country to go "where physics was being developed at the frontier." He got that opportunity as a student in the ICTP's yearlong postgraduate diploma program, which prepares students from the developing world for graduate school and a career in advanced research.

Cachazo would go on to complete his PhD at Harvard University and become a resident scientist at the Perimeter Institute for Theoretical Physics, in Canada. He is also a recipient of several international physics prizes. For "shaping my future," Cachazo gives credit to his mentors at the ICTP. "They were the architects of the path I would follow," he says.

Soon it may not be necessary for students and scientists from developing countries to venture so far from home to pursue frontier physics. That's because the ICTP—whose core mission is to conduct first-class research and to advance science in the developing world—is setting up proxy centers in the regions it serves. Five years ago ICTP director and Guatemalan national Fernando Quevedo made establishing regional centers of excellence a top priority, and this month it will be a centerpiece in strategic plans being unveiled at the ICTP's golden anniversary conference. Other new initiatives are aimed at increasing the participation of women in ICTP activities—current participation is around 23%—and sending early-career scientists as ICTP ambassadors for short-term teaching assignments in some of the least-developed countries.

Quevedo notes that the ICTP already has a presence in the developing world. He cites the workshops, affiliated centers, and scientific networks it sponsors. However, regional centers will be "more accessible to students and scientists who cannot make it to Italy," he says. Such centers are already operating in Brazil and Mexico (see PHYSICS TODAY, April 2012, page 29). Another one opened in Turkey this spring, and the newest ones are getting started in China and Rwanda.

Every year roughly 40 aspiring theorists from the developing world spend 12 months in Trieste, Italy, taking courses and conducting research at the Abdus Salam International Centre for Theoretical Physics' postgraduate diploma program, which started in 1991. The group shown here includes some of its first students. The ICTP experience will soon be available at regional partner institutions in Brazil, China, Mexico, Rwanda, and Turkey.

The problem of isolation

Each regional center is expected to raise funds from local and regional donors; the ICTP, which reports to UNESCO and the International Atomic Energy Agency, receives nearly 80% of its €30 million ($40 million) operational budget from the Italian government. So far, host governments of the regional centers have provided research space at local universities, and the ICTP has provided some initial startup funding.

At the ICTP in Trieste, outreach and educational activities include the postgraduate diploma program, graduate degree programs offered in collaboration with Italian universities, and an associates program for practicing scientists. Associates spend one- to two-month stints for up to six years conducting research and building collaborations.

Since its founding in 1964, the campus in Trieste has hosted more than 130 000 visitors, including 2500 associates—407 of them active this year—from 188 countries and some 600 diploma students from more than 100 developing countries. (For more examples of ICTP success stories, see "Developing theorists from the developing world" in the Singularities department at PHYSICS TODAY Online.)

Trieste has been the hub of ICTP activities that aim to address what founding director Salam called "the problem of isolation" in his March 1965 PHYSICS TODAY article "The International Center for Theoretical Physics" (page 52). The Pakistani particle theorist and eventual Nobel laureate wrote that the new center would be available for scientists from the developing world to visit "fairly frequently . . . to renew their contacts and engage in active research in fields like nuclear theory, high-energy physics, and the

theory of plasma and solid-state physics."

This year quantitative life sciences will become the newest research section at the ICTP; others are high-energy physics, condensed-matter physics, Earth-system physics, applied physics, and mathematics. (The ICTP's theoretical research programs, not including the newest one, are discussed in "The constant yet ever-changing Abdus Salam International Centre for Theoretical Physics" by Juan Roederer, PHYSICS TODAY, September 2001, page 31.)

According to Mohamed Hassan, a retired Sudanese nuclear fusion theorist, the "ICTP has really been the place where a scientist from the developing world can escape from the hectic life of teaching to do research and publish papers." Had he not discovered the center during his early days as a lecturer at the University of Khartoum, Hassan says he would have abandoned research. "I may have kept teaching, or done something else, like soap manufacturing," like his father did. Hassan was founding director of the World Academy of Sciences, also initiated by Salam and based in Trieste.

Region-specific research

Brazil was the first country to host a regional center. Founded in 2012, the ICTP South American Institute for Fundamental Research "has the luxury to focus on fundamental topics" thanks to a strong legacy in physics education and to a growing industrial sector, says Quevedo. Last year at host institution São Paulo State University, it held 15 regional and international workshops, meetings, and summer schools on such subjects as quantum theory, cosmology, and dynamical systems in biology.

In addition to fundamental physics and mathematical topics, the Mesoamerican Centre for Theoretical Physics in Mexico is focusing on energy and environment-related research. It is also working with the ICTP to create a program for students at universities in Central America and the Caribbean to earn physics or mathematics PhD degrees, which currently are not offered in the region. Located on the campus of the Autonomous University of Chiapas, the center hosted four scientific meetings in 2013, thanks to $200 000 from CONACYT, Mexico's science funding agency.

The ICTP–Eurasian Centre for Advanced Research, housed at the Izmir Institute of Technology in Turkey, will concentrate on theoretical subjects tied to technological applications. Energy, advanced materials, and bio-related topics are among the applications that acting director and condensed-matter physicist Tuğrul Senger lists as "compatible with the emergent needs of the developing countries in the region."

Former ICTP associate Yue-Liang Wu is helping to put plans in place for the Beijing-based ICTP–Asia Pacific. The center has secured space on the Yanqi Lake campus of the University of the Chinese Academy of Sciences. Wu, who is currently director of the Kavli Institute for Theoretical Physics China, says he expects that ICTP–Asia Pacific will train many of the 200 graduate students that the university admits annually from developing countries.

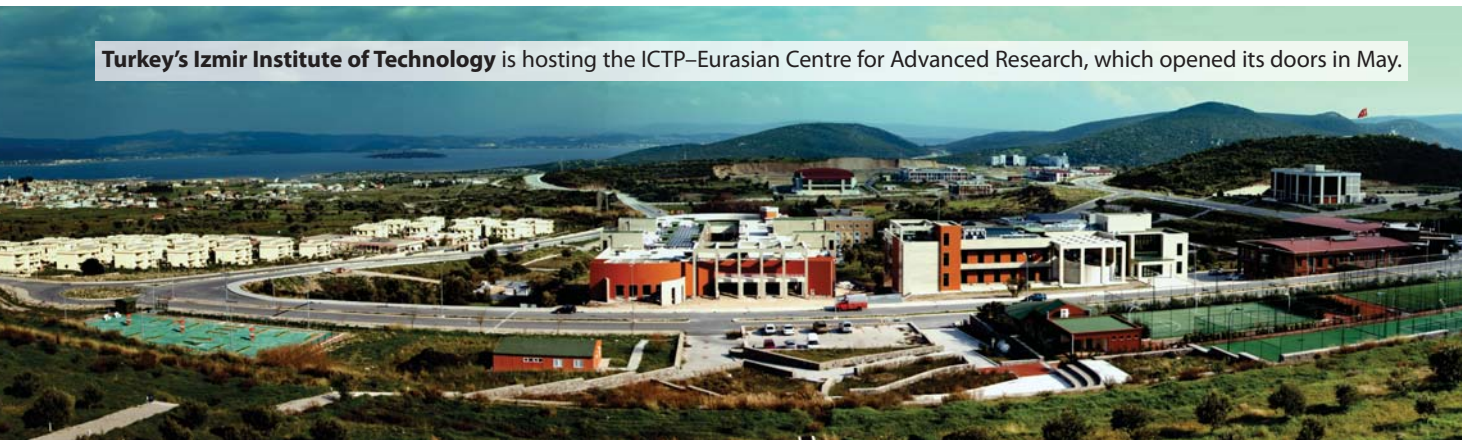
Despite its United Nations designation as one of the world's least developed countries, "Rwanda is one of the countries [on the African] continent most committed to using science for reducing poverty and increasing wealth," says mathematical physicist Romain Murenzi, director of the World Academy of Sciences and a former Rwandan science minister. The country's capital, Kigali, is hosting the ICTP East African Centre for Fundamental Research at the University of Rwanda. Initially, the center will focus on funneling students to the ICTP's postgraduate diploma program in Trieste, and to master's degree programs in medical physics and high-performance computing at the University of Rwanda.

Setting an example

Attracting funds and participants will depend on how well the new centers overcome conflict, corruption, and other destabilizing factors that plague many developing regions. Rwanda, a country scarred by genocide, is now "very secure and known for zero tolerance on corruption," says Murenzi. But many of its neighbors cannot say the same. And regional-center host China is considered "a political bully in the minds of many Filipinos" for using strong-arm tactics with the Philippines and other neighbors over disputed islands in the South China Sea, says ICTP diploma graduate Reinabelle Reyes, who works in Manila as a computer science professor.

Regional centers could have a significant impact "if they keep in mind the quality of research, the need to set examples to the young researchers, and if they make efforts to provide greater opportunities to the young and deserving people. Otherwise, they will amount to little," says Katepalli Sreenivasan, president and dean of engineering at New York University and a former ICTP director. "More than anything, what ICTP provides is an example of high-quality research for the many students and scientists that go through it," he says.

Some existing institutes with goals similar to the ICTP's stand as examples of what it takes to establish research and training institutions in the developing world. The African Institute for Mathematical Sciences (see PHYSICS TODAY, May 2008, page 25) has opened branches in four countries on the continent since



Turkey's Izmir Institute of Technology is hosting the ICTP–Eurasian Centre for Advanced Research, which opened its doors in May.

ICTP-ECAR

2003, when it launched the original center in South Africa. "We hope ICTP can learn from our experience," says Neil Turok, the institute's founder and current director of the Perimeter Institute for Theoretical Physics. "You have to be utterly dedicated. You have to be aware of the political sensitivities. And the international partners have to be aware that they are not in charge."

In addition to its support for the regional centers, the ICTP will continue to promote science in Africa and other parts of the developing world, says Joseph Niemela, head of the ICTP's applied physics section. In 2015 the ICTP's Office of External Activities, which Niemela also heads, will coordinate global activities for the UN-designated International Year of Light and Light-based Technologies, including a workshop in South Africa on fiber-optics technology. "If turnout and enthusiasm [for that event] are high, we will look to establish a Pan-African optics and photonics society," says Niemela.

"A lot of work and time goes into capacity building . . . but [those] efforts are paid back by seeing the progress achieved by individuals and also by research groups and institutions that have profited from our collaborations," says the ICTP's Ralph Gebauer. The Trieste-based condensed-matter physicist is cofounder of the ICTP-affiliated African Network for Solar Energy, which aims to foster research activities among African scientists in that field. Gebauer says one of his favorite outreach experiences happened in Africa; he was visiting a former ICTP diploma student who "presented his own first PhD student to me and explained that [he] was my scientific grandson."

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DARPA looks beyond GPS for positioning, navigating, and timing

Cold-atom interferometry, microelectromechanical systems, signals of opportunity, and atomic clocks are some of the technologies the defense agency is pursuing to provide precise navigation when GPS is unavailable.

Since its advent in the 1990s, the global positioning system has become ubiquitous in both the military and civilian worlds. But for all its precision, GPS has major limitations. Topping the list is its vulnerability to jamming of the signals from the GPS satellite constellation. Moreover, GPS does not work underwater or underground and can be degraded or unavailable during solar storms.

It's no wonder that the US Department of Defense has long been developing alternative positioning, navigation, and timing (PNT) systems that can operate independently of GPS. Five programs of the Defense Advanced Research Projects Agency (DARPA) are focused at least partly on PNT-related technologies.