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Global Research Infrastructures: A Decade of Science Diplomacy

Amy K. Flatten

In celebration of the tenth anniversary of the AAAS Center for Science Diplomacy, it is valuable to reflect upon common themes of some of the most frequently read articles that have been published in the Center's quarterly journal, *Science & Diplomacy (S&D)*. These pieces discussed the diplomatic impact of global research infrastructures such as the Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME), the International Space Station (ISS), the Abdus Salam International Centre for Theoretical Physics (ICTP), and the European Council for Nuclear Research, known as CERN.

In the fourth issue of S&D, published in late 2012, Chris Llewellyn Smith, in "Synchrotron Light and the Middle East," described the SESAME project, a remarkable partnership among Israel Iran, Palestine, Egypt, Jordan, Pakistan, Turkey, and Cyprus to build a research facility just outside of Amman, Jordan.[1] "Research and Diplomacy 350 Kilometers above the Earth," by the Canadian astronaut Julie Payette, highlighted the U.S.-Russian partnership toward space exploration.[2] "The Importance of International Research Institutions for Science Diplomacy," by ICTP Director Fernando Quevedo, compared the common missions of CERN and ICTP to convene the world's scientists to explore fundamental questions in physics.[1] These as well as other articles offer inspirational examples of

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researchers transcending national boundaries and political differences to share in the excitement and challenges of scientific discovery.

Today, research infrastructures convene international scientists in collaborations that highlight the most cherished values of science diplomacy—building bridges between communities, societies, and nations through scientific cooperation. In the years since these articles appeared in *S&D*, the ICTP has celebrated its fiftieth anniversary. It remains committed to providing scientists from developing countries with opportunities to conduct research and study the latest advances in physics and mathematics. Likewise, the ISS continues to unite astronauts from the United States, Russia, and other countries toward a common mission regardless of certain political tensions. Perhaps most notably, in May 2017, the SESAME project marked its official inauguration and is working to expand its experimental facilities, along with its promise of connecting Israeli, Arab and other researchers.

Ongoing Science Diplomacy: Diverse International Research Infrastructures

CERN provided the multinational model for establishing SESAME, with CERN's past directors-general serving as successive Presidents of the SESAME Council. In the past decade, CERN has added new member states and produced exciting discoveries such as the Higgs boson. Today, CERN's premise of international cooperation and scientific diplomacy continues to bring together scientists worldwide, providing them with some of the world's most complex scientific instruments to study the fundamental structure of the universe.

SESAME launched its experimental program in November 2017 with the XAFS/XRF beamline, delivering X-ray light for research ranging from solid-state physics to environmental science and archaeology. In April 2018, SESAME's second beamline came into service—the infrared spectromicroscopy beamline—enabling infrared microspectroscopy and imaging across varying fields, including materials science, biochemistry, archaeology, geology, cell biology, biomedical diagnostics, and environmental science.[2] SESAME will not only attract Middle East physicists to collaborate on shared scientific questions, it will also provide a light source for all international researchers across a spectrum of scientific disciplines.

Along with developments from SESAME, the ISS, the ICTP, and CERN, the past decade has seen many exciting examples of international research infrastructures, and diverse international partnerships producing new scientific discoveries. On February 11, 2016, the Laser Interferometer Gravitational-Wave Observatory (LIGO) Scientific Collaboration (LSC), which includes the multinational GEO Collaboration, the Australian Consortium for Interferometric Gravitational Astronomy, the Virgo Collaboration, and more than one hundred partner institutions across the globe, announced its monumental discovery of gravitational waves using the twin LIGO detectors located in Livingston, Louisiana, and Hanford, Washington. Their observation confirmed a major prediction of Albert Einstein's 1915 general theory of relativity. The LSC's expansion to multiple sites worldwide offers unprecedented opportunities for understanding cosmic events.

As the LSC enables monumental discoveries that offer new understanding of the cosmos, other global research infrastructures and their distributed centers are battling hunger and disease. The International Cancer Genome Consortium (ICGC) was established to launch and coordinate a large number of research projects sharing a common goal of unraveling the genomic changes present in many forms of cancer. By taking on data governance, ethical, and logistical challenges, the ICGC has enabled cancer-related global genomic data-sharing, providing the international community with comprehensive genomic data for many cancer types.[3] The International Brain Laboratory, a global neuroscience collaboration, has created a virtual laboratory, unifying **twenty-one neuroscience groups** distributed across the world. Together, their research will offer greater comprehension of certain brain functions that may underlie mental health disorders.[4] In the fight against hunger, CGIAR (formerly the Consultative Group for International Agricultural Research) consists of fifteen research institutes spanning five continents and is the largest global partnership addressing agricultural research for development.[5]

International Collaboration: Rising Opportunities, Continuing Challenges

Many countries appreciate that future large-scale international facilities and mega-science projects will require multiple national funding partners. Some scientists, however, express concerns over the lack of an effective mechanism to convene the international community for long-range strategic planning/mapping of future facilities within or across certain disciplines, asserting that international "participation" in collaborations fundamentally differs from international "planning" before a project's initiation. Granted, many scientific disciplines develop or advise on national plans or road maps that include large-scale international projects, and many scientists serve on government advisory committees. Road maps or recommendations from these groups, however, typically represent national strategies, focusing upon domestic scientific interests. While these national strategies may acknowledge needed global coordination for specific large-scale projects, the approach differs from long-term strategic planning of future large-scale facilities by (and for) the international community. Others may argue that future mapping of multiple large-scale international facilities, across multiple countries, is too ambitious given the various national interests involved.

Whether through large-scale collaborations and facilities, distributed institutional networks, or partnerships among individual investigators, science is inevitably becoming more global. U.S. scientists, for their part, are increasingly working with international peers through global infrastructures or small collaborations. According to the National Science Board's 2018 *Science & Engineering Indicators*, the share of U.S. academic publications coauthored with foreign institutions increased from 24.9 percent to 37.2 percent during the 2006–16 period. Federally funded research and development centers, where research focuses primarily on the physical sciences, have the highest proportion of international coauthorship of U.S. sectors, at 45.6 percent in 2016.[6]

Underlying any international research infrastructure, however, is an imperative for scientists to meet and to maintain professional contact with colleagues at home and abroad. In the past few years, scientists have faced politically based restrictions on travel, and the international scientific community has particularly decried certain U.S. travel bans. For example, the Council of the International Union of Pure and Applied Physics (IUPAP) issued a statement in October 2017 regarding restrictions on travel to the United States by citizens of specific countries. According to IUPAP's "Policy on Free Circulation of Scientists," these U.S. restrictions could jeopardize IUPAP support for U.S.-based international conferences.[7]

In response to these challenges to international cooperation, U.S. scientific and higher education organizations are joining together to: (1) convey to policy makers the national benefits of hosting international students and scholars; and (2) advocate for government policies favorable to international scientific mobility. Likewise, many of these groups are bridging the communication gap between scientists and everyday citizens, drawing attention to the many ways people's lives are enhanced by international scientific and technological advances; emphasizing how U.S. citizens benefit from international scientists working together to address shared challenges for all (e.g., disease, hunger, and sustainable energy); and highlighting the excitement of space exploration and new understanding of the universe.

Lastly, the successful participation of scientists in international research infrastructures relies upon a pipeline of young investigators, trained to embrace the challenges and opportunities of collaboration. Here, the international scientific community can underscore to school-age children and their parents how their own respective nations need a diversity of students to strive for excellence in science, technology, engineering and mathematics (STEM), regardless of their race, gender, or ethnicity. Students will learn that studying STEM in their home communities makes them part of a larger international science and technology enterprise. Hopefully, along with parents and policy makers, young people themselves will understand how expanding the diversity of STEM students can not only strengthen a nation, but also that their future participation in international research infrastructures will help them to build a better world.

Endnotes

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