Commentary

Physicists without borders

As an American in London and president of one of the world's great universities, I woke up early to the European Union referendum result that Friday morning in June and paused for thought. I reflected deeply about the value of international collaboration and mobility, and I realized Brexit was not the only concern. The rhetoric in the US presidential campaign was also isolationist. A few months later, I woke up early again to find that Donald Trump was to be the president of the US. We have run hot and cold on immigration in the US, and I have been dismayed at the experiences many highly accomplished scientists have had at the nation's borders.

In the broader view, I find that we must consider the political realities of wide swathes of people who feel that globalization has left them behind and that international mobility harms them. Even so, we need to make the case for scientists—and physicists in particular—to move freely across borders and around the planet.

On arriving in Princeton, New Jersey, as a graduate student, I discovered that many country inns in the region boasted that "George Washington slept here" or made some other claim to his presence. I think we should have just as much fun tracing the amazing paths great physicists have taken to their brilliant discoveries.

The 2016 Nobel Prize in Physics was recently split among three British physicists living and working in the US. Places they came from, places they passed through, and places where they are now have jointly—and rightly—celebrated accomplishments, past collaborations, and students mentored. Nobel Prizes should be widely feted, and the mobility of the awardees should be trumpeted, along with the collaborations spawned by the journey. Great ideas happen to brilliant people who learn things in every circumstance and from everyone they meet.

IMPERIAL COLLEGE LONDON

Alice Gast, president of Imperial College London, talks with a student from China.

Whereas the three 2016 Nobel laureates lived and worked in the UK, France, the US, and Finland, fiber-optics pioneer Charles Kao was born in Shanghai, China, moved to Hong Kong, and studied in Greenwich and London in the UK. He then went back to Hong Kong, moved to the US, spent a year in Germany, returned to Hong Kong as vice chancellor of the Chinese University of Hong Kong, and then took a sabbatical at my institution, Imperial College London. He now lives in California. One can only imagine the visas he has held and the paperwork he has had to fill out.

Some major advances in physics in the late 20th century arose precisely because Soviet bloc scientists, people who had previously been denied exit visas, were free to travel. The mobility of Chinese scientists since the 1980s has also had a noticeable effect.

Clearly, physicists get around; they are global citizens. Scientists and engineers from 120 countries collaborate at CERN, where solving challenging problems transcends political differences and the science requires collaboration on a global scale. It becomes irrelevant where they were born or what passport they hold. Like Doctors Without Borders (Médecins Sans Frontières), who help patients regardless of politics or nation, scientists without borders work together because they are motivated by challenges they often could not solve alone.

Can we envision a utopian future with international passports or global green cards for our best and brightest scientists? That may be a step too far in an era of backlash against globalization, but we can at least look at some pragmatic ideas to foster mobility.

Students are perhaps more mobile, since they are often without family ties or extensive duties at their home institution. A remarkable number of great physicists and other scientists were once foreign students or postdocs. Among the Nobel

CONTACT PHYSICS TODAY

Letters and commentary are encouraged and should be sent by email to **ptletters@aip.org** (using your surname as the Subject line), or by standard mail to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842. Please include your name, work affiliation, mailing address, email address, and daytime phone number on your letter and attachments. You can also contact us online at **http://contact.physicstoday.org**. We reserve the right to edit submissions.

Prize recipients in physics and chemistry since 1980, almost 40% were working in a foreign country; this year all six are.

Many scientists in the US and UK first came to the two countries as students or postdocs. In the aftermath of 9/11, the US tightened its borders, and students from some countries had much more difficulty going to the US. The onerous processes and anti-immigration rhetoric took their toll, and between 2001 and 2006, the number of international students dropped.

At the same time, other countries improved their environment for talented scientists. I worked during that time on a report for the Committee on Science, Engineering and Public Policy at the US National Academies; in it we made recommendations to improve the international student visa process. The numbers have increased since 2007, and according to the Institute of International Education, international students now make up 4.8% of the US student population. The number of international students in physical and life sciences in the US averages around 7–10%. The US is still a very attractive destination.

The flow of students should not be only in one direction. Studying in another country would be good for US students too, yet too few do so. A similar percentage, 7–8%, of US students abroad are in the physical and life sciences; however, in 2013–14 just over 300 000 studied abroad while the US attracted almost 900 000 foreign students.

International students can become great scientists, and they can become entrepreneurs too. One notable physicist-immigrant turned entrepreneur is Stephen Wolfram, whose innovations in computational algebra have influenced many of us. A study by AnnaLee Saxenian showed that in 1998 almost a quarter of Silicon Valley's technology companies were headed by Indian and Chinese computer scientists and engineers.[1] Saxenian, Vivek Wadhwa, Ben Rissing, and Gary Gereffi extended that study to show that from 1995 to 2005 more than half of the Silicon Valley technology and engineering companies had at least one immigrant founder.[2] A 2012 study from the Partnership for a New American Economy found that immigrants to the US were "more than twice as likely as the native-born to start a business."[3] Further, according to Wadhwa, "immigrants started nearly half of America's 50 top venture-funded companies and are key members of management or product development teams in more than 75% of those companies."[4]

Competition for talented people has grown. You see that in entrepreneurial activity. Wadhwa describes the slowing and reversing trend of new enterprises founded or partly run by immigrants.[5] He and his research collaborator Alex Salkever ascribe the problem to the increasing competition from startup markets in India and China and to post-9/11 visa policies, which, while now mostly reversed, set a tone for foreigners. Despite improvements in visa policies, foreign students' desire to remain in the US declined. Only 6% of Indian and 10% of Chinese students in their 2008 survey wanted to stay in the US. The grass was starting to look greener in their home countries.

In his book, Wadhwa estimates that it takes approximately 13 years to start a successful company,[4] and the US H-1B and green-card process makes that time span difficult for foreigners. Thus immigrant-founded companies in Silicon Valley decreased from more than 52% in 2005 to less than 44% in 2012. Perhaps more important than founders, the immigrant workforce fueling tech companies has shrunk dramatically, with 180 000 Chinese returning home in 2011 compared with the 330 000 students who left China that year. In 2008 only 50 000 Chinese graduates returned home. Those aptly named "sea turtles" (see PHYSICS TODAY, August 2010, page 12, and January 2011, page 9) are building the scientific capability and startup environment back home.

Of course, if we want to enable such mobility we need national and international policies that ensure movement across our countries' borders. We need to promote wise and reasoned immigration policies that allow talented people to move about. A conference here, a sabbatical there, a two-week holiday hiking in the mountains, all are ingredients in the recipe for insight, discovery, invention, and creativity.

In this period of populist retreat from globalization, we need to more broadly promote the benefits of freedom of movement. If we can do that, any town may soon be lucky enough to boast of a physicist or startup tech company.

References

1. A. Saxenian, *Silicon Valley's New Immigrant Entrepreneurs*, Public Policy Institute of California (1999).
2. V. Wadhwa, A. Saxenian, B. Rissing, G. Gereffi, *America's New Immigrant Entrepreneurs*, Duke U. and U. California, Berkeley (2007).
3. R. W. Fairlie, *Open for Business: How Immigrants Are Driving Small Business Creation in the United States*, Partnership for a New American Economy (August 2012).
4. V. Wadhwa, *The Immigrant Exodus: Why America Is Losing the Global Race to Capture Entrepreneurial Talent*, Wharton Digital Press (2012).
5. V. Wadhwa, A. Saxenian, R. Freeman, A. Salkever, *Losing the World's Best and Brightest: America's New Immigrant Entrepreneurs, Part V*, Ewing Marion Kauffman Foundation (March 2009).

Alice P. Gast
(president@imperial.ac.uk)
Imperial College London

LETTERS

X-ray sterilization with accelerators is viable in US

David Kramer's piece on gamma irradiators (PHYSICS TODAY, August 2016, page 27) discusses the tricky position governments are in with respect to product sterilization facilities based on cobalt-60. Making current facilities safer and more secure directly addresses the threat of a radiological dispersion device based on ^{60}Co but might be seen as subsidizing the status quo. From the US industry perspective, however, practical steps taken today are not at odds with the demonstrated long-term commitment by the Department of Energy to curtail the commercial use of materials suitable for a dirty bomb.

Our group at Niowave Inc is an example of a private-sector effort to develop an alternative technology to large ^{60}Co-based irradiators. We build superconducting electron linacs with high-power x-ray converters for applications such as high-throughput sterilization. Kramer correctly noted that electron