

UK science mired in uncertainty about Brexit

The most immediate concern is that the country remain attractive and welcoming for foreign researchers and students.

The clock will begin to tick this month on the UK's exit from the European Union (EU). Once it does—as soon as Prime Minister Theresa May's government triggers the EU exit clause, Article 50—a two-year countdown begins until “Brexit” becomes reality. During that time, the UK and the EU will try to redefine their relationship in what portends to be a messy divorce after a 40-year marriage that brought both economic prosperity and high levels of immigration.

The passage on 23 June 2016 of the Brexit referendum stunned the science communities in the UK and beyond. And the uncertainty of how Brexit will actually play out is taking a toll. In general, scientists believe that the global science enterprise, and science in the UK, has benefited greatly from the easy movement of scientists throughout Europe and from the multinational grants obtained through the EU.

The UK government understands that science is an international activity, says John Womersley, who recently moved from heading the Science and Technology Facilities Council, one of seven UK funding agencies, to take the reins of the European Spallation Source (ESS) in Lund, Sweden. “I don't think there is a desire to see less collaboration or to pull up the drawbridges as far as science is concerned. But the drawbridges may get pulled up by other demands, and then science will need to build other bridges,” he says.

For science, the main concerns related to Brexit are the intertwined complications in travel and residency for researchers and students, funding, participation in European projects, and access to scientific infrastructure.

Psychological effects

“The first issue is to try and persuade EU scientists working in the UK that they are still welcome,” says John Selborne, chair of the House of Lords Science and Tech-



MEMBERS OF THE PHYSICS DEPARTMENT at Durham University hold up their national flags as part of a Twitter campaign (#scienceisglobal) by the Royal Society. Department chair Simon Morris is in the front, holding the flags of the US and the UK.

nology Committee. “We have done enormously well in attracting people. And the immediate effect of the uncertainty of Brexit is corrosive.” Unlike other foreigners, EU citizens don't need visas to live and work in the UK, but their future status is uncertain. Immediately after the referendum, some scientists and their families from EU countries—like other foreigners—were taunted and told to go home.

Across UK universities, non-UK EU citizens make up about 17% of the more than 200 000 academic staff, according to the UK Higher Education Statistics Agency. Science departments in the UK are even more international: In physics 27% of faculty and staff are from non-UK EU countries; another 18% come from outside the EU. In EU collaborations, says Simon Morris, chair of physics at Durham University, “we exchange post-docs and graduate students all the time.

It's delightfully easy. With Brexit, we've just given all of that away.”

Much of the effect so far is psychological, says Max Klein, a particle physicist from Germany who has been at the University of Liverpool for a decade. “We believe our personal status will basically be untouched,” he says. “You can't send thousands of teachers away. The universities would stop functioning.” The government says it wants to keep the most intelligent people, he adds, “but this is offensive. We are being used as a bargaining chip for the discussions to come.” On the other side of that equation are the many UK nationals in other parts of Europe; Spain, for example, is a favorite retirement destination.

Scientists across the UK tell stories about receiving fewer EU job applications and faculty posts being turned down with Brexit cited as a factor in the



decision. They also say many UK-based EU scientists are putting out feelers for jobs in other countries.

"Recruitment of the very best people will get more difficult because such a large proportion of them are from Europe," says Andrew Harrison, head of the Diamond Light Source in Harwell. "I think we can still get people here, but we have to work harder to do so." The situation is exacerbated by fears that even if skilled workers such as university faculty can get a visa after Brexit, it may be harder for their spouses. "Anything that makes the UK less attractive will hurt our competitiveness in the global research scene," he says.

If EU citizens are subject to the same rules as students from other countries—China, India, Russia, and the US, for example—they will no longer be eligible for reduced university tuition or government-backed student loans. At present, university tuition for EU citizens in England and Wales is £9000

(\$11 300) a year, in Northern Ireland it's less than half that, and in Scotland it's free. For non-EU citizens it's decided by individual institutions and is £15 000–£20 000. Scottish physicist Andy Mackenzie, a director of the Max Planck Institute for Chemical Physics of Solids in Dresden, Germany, says the tuition issue could strike home for his family: "I have three teenagers. They intend to go to university in the UK." The reduced UK tuition is based on residency during the prior three years. For Mackenzie's kids to be eligible would take a continued reciprocal agreement with the EU.

Negotiations over the terms of the UK's exit are still to come, but the UK government is taking a hardline stance on immigration and visas. Its starting point is that immigration should be reduced and that students should count in the quotas.

"Britain is now seen as a risk"

Because of Brexit, the UK stands to lose out on EU programs that promote the exchange of students and more senior researchers. Also at risk is UK access to EU science facilities and participation in the EU framework programs—seven-year research programs run by the European Commission, including support for the European Research Council (ERC) and for multinational research projects. (See *PHYSICS TODAY*, March 2014, page 26.) The UK has done well in winning research money from the EU. For the period 2007–13, the UK contributed €5.4 billion (\$5.8 billion) for EU research, development, and innovation activities and received grants totaling €8.8 billion, according to the UK Office of National Statistics.

Many UK physics departments get a significant portion of their research funding through ERC grants. After the financial crisis in 2008, the EU framework program rescued the Imperial College London physics department, says its head, Jordan Nash. "We went from around 7% to 22% of our research funding being European. We used it to plug a hole caused by a freeze of investment by the national government." Crucially, the ERC money is largely for fundamental research, without a need to prove immediate applications.

Even though the UK is still part of the EU, stories abound about UK partners being asked to take a less prominent role, or to not participate, in scientific collab-

orations. "I have heard firsthand of consortia who would once have had a British member but now prefer to avoid it because of uncertainty," says Mackenzie. "To get an EU grant is incredibly competitive, and any negative perceptions during the decision-making process can be tie-breakers. People are risk averse, and Britain is now seen as a risk."

Still, says Womersley, "money is just money, and that problem can be solved by putting in more money." The bigger problem, he says, "is one of collaborations, organizations, and membership." The ERC requires scientists from different countries to work together. "That has been quite special and allows groups to reach critical mass," says the University of Glasgow's Sheila Rowan, who works on gravitational waves. "The framework and structure that Europe provides—despite the bureaucracy—has helped facilitate collaborations. It's not a natural stance to think of withdrawing from those close collaborations."

The concerns for science in Northern Ireland and Scotland, whose electorates both voted against Brexit, mirror those elsewhere in the UK but with heightened uncertainties due to regional politics. Just over a year and a half before the Brexit referendum passed, Scotland voted narrowly to remain in the UK. A separation may be revisited if Scotland doesn't like the final Brexit deals. But entry into the EU for an independent Scotland wouldn't be automatic and could even be vetoed by Spain or some other country interested in discouraging breakaway regions.

The only land border between the UK and the EU is the one separating Northern Ireland and Ireland, and for economic growth and peace, people on both sides of it are keen to avoid disrupting free movement of people and goods. The big questions go beyond science, but anything that hinders interactions would be damaging, says Robert Bowman, who heads the school of mathematics and physics at Queen's University Belfast. "Scientific endeavors shouldn't have boundaries or barriers."

No sweetheart deals

Given its anti-immigration attitude, the UK government is unlikely to be able to buy back regular membership for the country in EU research programs. Norway, for example, is not an EU member, but it has signed on to free movement of people and participates in the ERC and

other EU programs. An alternative approach for UK researchers may be to participate in pan-European projects, but with successful proposals funded from home rather than out of the EU pot. Such a model, adopted by the EU for Japan, Mexico, and Russia, among others, facilitates collaborations and widens the pool of applications, which tends to raise the quality of funded projects.

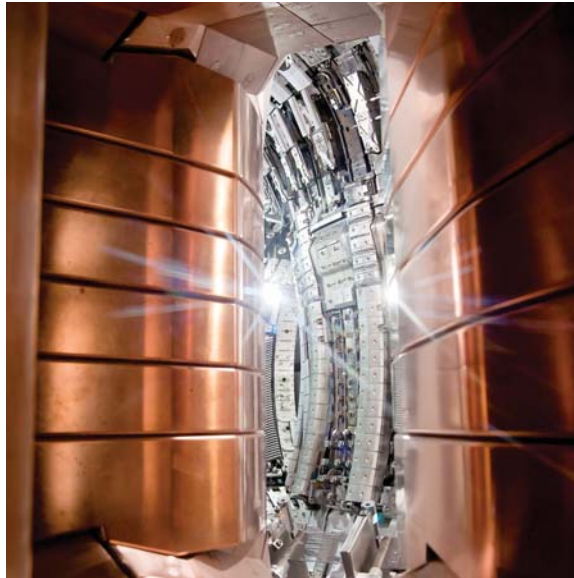
According to Selborne, the UK may lose all power to shape EU science programs under the likely post-Brexit scenarios. The eligibility of UK companies to bid for contracts on EU projects will also depend on the outcome of Brexit negotiations.

Although most scientists in Europe are keen to keep collaborating with UK scientists, EU leaders may want to send the message to other countries that leaving the EU has consequences. Permitting the UK to take an à la carte approach to EU programs may not be acceptable to the rest of the EU. "Now that we have rattled the stability of the EU," says Morris, "the EU won't give us a sweetheart deal. It will be hard negotiations." Or, as Rolf-Dieter Heuer, head of the German Physical Society, puts it: "What would you do if a member quits, and then wants to pick out the raisins of the EU?"

Siegfried Bethke, a director at the Max Planck Institute for Physics in Munich and a member of the European Physical Society council, sees Brexit as "a human and social tragedy, and it will have a bad influence in all areas of normal life, especially in the UK." He expects the negotiations over UK participation in EU science programs "will take years. That could be damaging. Nothing is worse than fears instead of facts."

Facility access in jeopardy

Also to be sorted out is the extent to which UK scientists can continue to access European science infrastructure. Some facilities, notably CERN, the European Space Agency, and the European Southern Observatory, are organized through treaties, so they won't be directly affected by Brexit. "But a lot of research grant money that underpins our participation in those facilities comes from EU grants," says Morris. "That



THE FUTURE OF THE JOINT EUROPEAN TORUS, a magnetic fusion machine in the UK, is up in the air now that the country intends to leave Euratom in tandem with exiting the European Union.

money will go away and we will have to find replacement money."

Where membership is through EU legal structures, arranging for the UK's continued participation will be trickier. Those facilities include the ESS and the Extreme Light Infrastructure under construction in the Czech Republic, Hungary, and Romania (see *PHYSICS TODAY*, March 2010, page 24, and June 2010, page 20). Perhaps most at risk is access to small- and medium-scale facilities—computational, fabrication, and characterization resources—in EU-supported networks. An example is Laserlab Europe, which opens beam time at facilities throughout Europe to EU-based researchers, says Marco Borghesi, a physicist at Queen's University Belfast. "When EU membership goes, this very useful capability will almost certainly be stopped."

In late January the UK government confirmed that along with withdrawing from the EU, the UK will also step out of Euratom, the European Atomic Energy Community, the body responsible for safe use of nuclear energy across Europe. Because Euratom facilitates the transport of nuclear materials, services, and people, that move could disrupt the country's nuclear industry, including delaying the financing and construction of future power plants. Quitting Euratom also casts uncertainty over the UK's continued membership in ITER, the interna-

tional fusion test reactor under construction in Cadarache, France.

Another effect of the withdrawal will be to "put in jeopardy the continued operations of JET," says Ian Chapman, director of the Culham Centre for Fusion Energy, home to the Joint European Torus in Oxfordshire, UK. JET is the only fusion machine that can run with deuterium and tritium; it's used as a test bed for ITER. Chapman notes that £50 million a year, more than half of the facility's budget, currently comes from Euratom.

"We are exploring options for continued participation in ITER, outside of full membership in

Euratom," he says.

No silver lining

Scientists were overwhelmingly against Brexit. Pre-vote polls put their numbers for remaining in the EU at 93%. Martin Rees, a University of Cambridge astronomer and member of the House of Lords, says he thinks that as negotiations proceed, any deal "will only have minority support among all voters" and that a second referendum is "a realistic thing to hope for."

Last fall the UK government announced an increase in money for research and innovation, to the tune of £2 billion a year by 2020. "That's a positive sign amidst the gloom," says Diamond's Harrison. "It's a public declaration that the government supports science." Still, he cautions, "we don't know yet what the money will go toward." The May government has also promised to cover UK scientists' share in European grants that extend beyond Brexit.

The government is touting Brexit as an opportunity for the UK to look beyond Europe for partners in trade and science. But scientists, who already collaborate with colleagues around the world, mostly reject that as a silver lining. On the contrary, argues Rees, "we will be less attractive to other countries if we cannot offer links to European networks."

Triggering Article 50 will force the government to "crystallize its vision and present some idea of what will happen in the next two years," says Imperial's Nash. "But there are so many things to negotiate. It's a big logistical challenge and means years of uncertainty."

Toni Feder