

The International Year of Quantum: Engaging the next generation



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2025 is the UN's International Year of Quantum Science and Technology (IYQ), aimed at giving fresh impetus to the world's understanding of quantum. The Institute of Physics (IOP), as professional body and learned society for physics in the UK and Ireland, has led on this in the UK on behalf of the Department for Science, Innovation & Technology. This has included coordinating activities run by a wide range of groups and putting on a series of high-profile events to raise awareness of how quantum is changing our lives for the better, including taking the message to parliament and government.

Why celebrate quantum, why an international year, why this year?

Put simply, the first generation of quantum technology has touched every part of modern life. It has underpinned the digital revolution over the last 100 years – in the form of lasers, optical fibres, semiconductors and much more – yet quantum has remained an enigmatic science in many ways.

2025 marks a century since the German physicist Werner Heisenberg's paradigm-shifting formulation of quantum mechanics. Since then, quantum mechanics has profoundly transformed our understanding of the natural world and the nature of matter. The innovations in technology it has driven that have benefitted humanity are myriad.

In the UK, the government set up the National Quantum Technologies Programme in 2014 to accelerate the development and commercialisation of quantum technologies and with a £1bn initial investment gave the UK a strong foundation to build on. By most

measures, over a decade on, the UK is a global leader in quantum, with the second largest private sector investment and third largest quantum sector in the world.

Quantum is beginning to take the shape of a genuine new industry in its own right and just like the emergence of other revolutionary technologies – the invention of the railways two hundred years ago this year, the combustion engine, the internet, AI – the next wave of quantum will change our world in ways we cannot yet imagine.

The influential Institute of Physics 2022 report *A Vision for Quantum Technologies in the UK* aimed to support the development of a national quantum strategy. In 2024, this call was answered when the government announced a £2.5bn 10-year plan for quantum – the UK's largest ever long-term investment in an emerging technology.

This commitment gives long-term certainty to support private investment and new business creation and gives the UK a strong position in the commercialisation of quantum technologies.

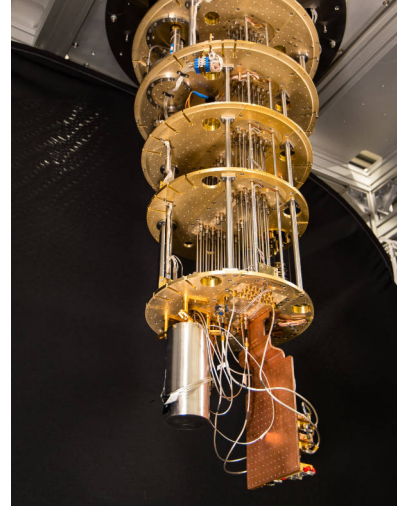
In response to the opportunity quantum represents, IOP members set up a quantum Business Innovation and Growth (qBIG) group and alongside their very busy schedule of networking activities they award the qBIG prize, celebrating small and medium-sized startups taking quantum technology services and products to market. It offers a £10k prize and mentoring from quantum VC specialists Quantum Exponential plus access to the IOP's Accelerator space, which is now home to nine quantum start-ups.

The science, however, remains one of the hardest to explain to non-physicists. That's why the public engagement opportunities the IYQ offers are so important – you don't need to understand quantum to understand its potential. So alongside celebrating with the physics community, we have sought to engage the public – especially the next generation – and to support political momentum.

To reinforce the message, in June we brought a quantum exhibition to the Houses of Parliament showcasing real-world applications and the future possibilities of quantum science. Alongside the exhibition, we hosted a drop-in event where parliamentarians could meet quantum physicists and businesses driving innovation. Our goal was clear, to demonstrate that quantum is not just a scientific frontier where the UK is a global leader but also a strategic investment for the UK's long-term prosperity.

At the start of November, the IOP welcomed hundreds of people to events at the Royal Institution to learn about the history of quantum and to explore its future as part of a broader IYQ-focused week of activities dubbed "quantum week".

Expert speakers from academia, government and business gave people the opportunity to hear more about quantum development, its importance to the UK, and how this technology could change our future. Theoretical physicist Professor Jim Al-Khalili OBE, an IOP honorary fellow and well-known broadcaster, gave a keynote speech highlighting the many opportunities presented; by quantum timing, imaging,



Left to right: Jim Al-Khalili and some young quantum enthusiasts; The IOP's event at the Royal Institution; A multi-stage dilution refrigerator used for cooling superconducting quantum processors to millikelvin temperatures, with layered gold-plated plates and wiring for qubit control and readout (photo by permission of National Quantum Computing Centre)

sensing, encryption, internet and the holy grail of quantum research, quantum computing.

Quantum week attracted delegations from around the world and other highlights included a National Physical Laboratory event – where science minister Patrick Vallance launched NMI-Q, a global network of measurement bodies to shape quantum standards – and the UK National Quantum Technologies Showcase 2025, organised by Innovate UK, which this year attracted more than 3000 attendees – a tangible sign of the industry maturing into a new industrial sector.

Applications of quantum: why is this such a special area of physics?

Quantum mechanics explains how matter and energy interact at the smallest scales. Over the past 100 years physicists have discovered that particles at this level behave in ways that defy classical physics, challenging our traditional understanding of the material world.

While this has changed our understanding of the world on a fundamental level, quantum phenomena such as entanglement and tunnelling have also led us to technological advances that have profoundly altered the ways we live. These applications – from phones to computers – are all around us and the world would not function as we know it without our understanding of quantum mechanics.

And this science is increasingly coming into plain sight. The revolutionary first wave of quantum technology promises to be eclipsed by a second wave that

leverages the counterintuitive ways the quantum world works. Quantum computers, for example, will enable computing to be done in a fundamentally different way – some calculations will be done exponentially faster than a classical computer. This will change how we work, how we problem solve, how we diagnose and treat health issues and how we interrogate the world around us.

But while the way the second quantum technology revolution will shape our future can be glimpsed, there are still many unanswered questions.

The application of quantum mechanics in encryption and cybersecurity throws up the twin possibilities of new, more powerful, encryption tools, as well as more well-known decryption methods – a real cause for concern in industries and governments working with and trying to protect sensitive data.

Scientists talk of 'q-day', the fast-approaching point at which quantum computers should be able to crack RSA encryption, which is widely used across the internet to secure sensitive data for instance for financial transactions. New standards will be required to manage the threat posed by the cryptographic powers of quantum computers – organisations such as the National Institute of Standards and Technology are already working on what will be a hugely complex problem to solve.

As the quantum sector continues to emerge, there is a responsibility on us all to ensure it works towards a common good. The IOP promotes this work across the physics ecosystem: alongside our expert members, universities, politicians

and policymakers, funders, and physics-based businesses (the latter of which in 2023 accounted for 11% of UK GDP). Elsewhere UKQuantum is collaborating with the ecosystem on the Responsible Quantum Industry Forum.

Other challenges in developing the industry.

We face many obstacles, one of which is the very real skills gap. Two-thirds of businesses we surveyed told us they have had to stop or delay R&D over the last five years, because of a lack of relevant skills. Meanwhile, a quarter of our state schools don't have a specialist physics teacher at GCSE level, leading to a postcode lottery of access and likelihood of taking physics study further.

And while we are seeing small positive changes (this year physics jumped from the ninth to sixth most popular A-level choice) physics is still the 15th most popular A-level choice among girls and the 2nd among boys – a very strong indication of the kind of messages girls and young women are getting about physics – something we're working hard to change through our pioneering 'Limit Less' programme.

So there is huge opportunity, and also significant challenge. We are hoping the International Year of Quantum Science and Technology inspires the next generation of physicists to seize that opportunity and tackle the challenges with us. The UK was an early mover in this area and has maintained an important role as a global quantum leader, it is down to us all to maintain the UK's well-earned position.