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careers 2025

INTERNATIONAL YEAR OF
Quantum Science
and Technology

case studies • employer directory • careers advice

100 years on from the initial development of quantum mechanics, 2025 has been chosen as the International Year of Quantum Science and Technology. This year's guide contains a series of special articles to celebrate the many advances made in the quantum realm over the last century, and shines a light on some pioneering researchers in the field.

INTERNATIONAL YEAR OF
Quantum Science
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Foreword

Welcome to ***Physics World Careers 2025***, a guide to the many career opportunities open to physics graduates.

With the United Nations having declared 2025 as the International Year of Quantum Science and Technology, it's a wonderful time to celebrate not just the exciting fundamental work going on in quantum physics but the huge applications of the field too – whether that's quantum computing, sensing or communication.

As chair of the quantum Business and Innovation Growth (qBIG) Group of the Institute of Physics (IOP), which publishes *Physics World*, I'm therefore delighted that this year's *Physics World Careers* guide has a strong quantum theme. In particular, there's a great article with advice on how to break into the quantum workforce.

Having moved between academic institutions, start-up firms and large corporations – and now being an employer myself – I have seen how valuable a degree in physics can be when it comes to carving out a career. This guide highlights many of the options open to you, from engineering and education to meteorology and policy.

In addition to this guide, don't forget that the IOP offers many other resources and support to its members at all career stages. You can find out more about the IOP's careers and professional development at **www.iop.org/careers**.

I hope you find this guide useful and wish you all the best as you embark on your future careers.

Anke Lohmann
Founder of Anchored In Ltd and chair of the IOP quantum Business Innovation and Growth Group


Andy Doherty/Institute of Physics


Queen's University Belfast


Laura Tobin


Prineha Narang

Your route to success

As a physics graduate, you have a myriad of career opportunities open to you, and our annual *Physics World Careers* guide is here to help you navigate the jobs marketplace. Indeed, your technical talents, expertise and knowledge as a physicist are in high demand, as employers from sectors as varied as healthcare, engineering and data science are looking for people with physics skills.

Our guide is here to help you find the right job that matches your skills and interest, while also helping you discover all the job prospects available to you. This 9th edition of our guide has a special quantum theme as the United Nations has deemed 2025 to be the International Year of Quantum Science and Technology (IYQ). From fundamental research to computing, cryptography, sensing and even healthcare and the environment, quantum applications are set to revolutionize our world. And employers across the sector are looking to hire physicists just like you, so make sure to look out for the IYQ logo (right) for our quantum-focused content

Tushna Commissariat, editor of *Physics World Careers*, helps you explore your career opportunities

While many physicists dream of making world-changing discoveries, perhaps you would rather help shape the path of someone else's future? If the idea of guiding bright young minds appeals to you, then you might want to consider becoming a teacher, and you can read more about Teacher Training Scholarship schemes in the careers development section (p16).

In our "Case study" section, you can learn more about the physicists working in a variety of roles across academia and industry – from meteorology to material science. And for all your career queries, top researchers in our "Ask me anything" section are keen to share their best tips and tricks with you.

As always, we also have a comprehensive "Employer directory", where you can find out more about companies and institutions currently hiring physics graduates. If you're ready to start your job search, do explore all the latest opportunities on *Physics World Jobs*, where you can find vacancies in physics and engineering for people at all career stages. And there's our one-stop shop *Physics World Jobs Partner Network* Jobs hub where you can find information, inspiration and guidance. Also, don't forget to subscribe to the *Physics World* careers newsletter, simply by signing into your free *Physics World* online account and ticking the "Careers bimonthly" box.

This year's guide truly highlights the wide scope of stimulating and satisfying careers available to all those graduating with a degree in physics. I hope that *Physics World Careers 2025* helps you on your own special path.

Editorial contents

Physics World Careers 2025
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FEATURED EMPLOYERS

Employer directory

Explore the quantum frontier:

all about the International Year of Quantum Science and Technology 2025

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From public talks and hackathons to festivals and careers events, **Tushna Commissariat** gives you a whistle-stop tour of key activities in the IYQ calendar across the UK

In June 1925, a relatively unknown physics postdoc by the name of Werner Heisenberg developed the basic mathematical framework that would be the basis for the first quantum revolution. Heisenberg, who would later win the Nobel Prize for Physics, famously came up with quantum mechanics on a two-week vacation on the tiny island of Helgoland off the coast of Germany, where he had gone to cure a bad bout of hay fever.

Now, a century later, we are on the cusp of a second quantum revolution, with quantum science and technologies growing rapidly across the globe. According to the *State of Quantum 2024* report, a total of 33 countries around the world currently have government initiatives in quantum technology, of which more than 20 have national strategies with large-scale funding. The report estimates that up to $50bn in public cash has already been committed.

It's a fitting tribute, then, that the United Nations (UN) has chosen 2025 to be the International Year of Quantum Science and Technology (IYQ). The year aims to raise global awareness of the impact that quantum physics and its applications have already had on our world. The UN also hopes to highlight to the global public the myriad potential future applications of quantum technologies and how they could help tackle universal issues – from climate and clean energy to health and infrastructure – while also addressing the UN's sustainable development goals.

The Institute of Physics (IOP), which publishes *Physics World*, is one of the IYQ's six "founding partners" alongside the German and American physical societies, SPIE, Optica and the Chinese Optical Society. "The UNESCO International Year of Quantum is a wonderful opportunity to spread the word about quantum research and technology and the transformational opportunities it is opening up," says Tom Grinyer, chief executive of the IOP. "The Institute of Physics is co-ordinating the UK and Irish elements of the year, which mark the 100th anniversary of the first formulation of quantum mechanics, and we are keen to celebrate the milestone, making sure that as many people as possible get the opportunity to find out more about this fascinating area of science and technology," he adds.

"IYQ provides the opportunity for societies and organizations around the world to come together in marking both the 100-year history of the field, as well as the longer-term real-world impact that quantum science is certain to have for decades to come," says Tim Smith, head of portfolio development at IOP Publishing. "Quantum science and technology represents one of the most exciting

AUDIO Quantum physicist Mete Atatüre, from the Cavendish Laboratory at the UK's University of Cambridge, talks about hosting the quantum light source and his group's research on quantum sensors and quantum networks.

The IOP will use the focus this year gives us to continue to make the case for the investment in research and development, and support for physics skills, which will be crucial if we are to fully unlock the economic and social potential of the quantum sector

and rapidly developing areas of science today, encompassing the global physical-sciences community in a way that connects scientific wonder with fundamental research, technological innovation, industry, and funding programmes worldwide."

The official opening ceremony for IYQ takes place on 4–5 February at the UNESCO headquarters in Paris, France, although several countries, including Germany and India, held their own launches in advance of the main event . Working together, the IOP and IOP Publishing have developed a wide array of quantum resources, talks, conferences, festivals and public-themed events planned as a part of the UK's celebrations for IYQ.

In late February, meanwhile, the Royal Society – the world's oldest continuously active learned society – will host a two-day quantum conference. Dubbed "Quantum Information", it will bring together scientists, industry leaders and public-sector stakeholders to discuss the current challenges involved in quantum computing, networks and sensing systems.

In Scotland, the annual Edinburgh Science Festival , which takes place in April, will include a special "quantum explorers" exhibit and workshop by the UK's newly launched National Quantum Computing Centre. Elsewhere, the Quantum Software Lab at the School of Informatics at the University of Edinburgh is hosting a month-long "Quantum Fringe 2025" event across Scotland. It will include a quantum machine-learning school on the Isle of Skye and well as the annual UK Quantum Hackathon, which brings together teams of aspiring coders with industry mentors to tackle practical challenges and develop solutions using quantum computing.

In June, the Institution of Engineering and Technology is hosting a Quantum Engineering and Technologies conference, as part of its newly launched Quantum technologies and 6G and Future Networks events. The event's themes include everything from information processing and memories to photon sources and cryptography.

Further IYQ-themed events will take place at QuAMP, the IOP's biennial international conference on quantum, atomic and molecular physics in September. Activities culminate in a three-part celebration in November, with a quantum community event led by the IOP's History of Physics and quantum Business and Innovation Growth (qBIG) special interest groups, a schools event at the Royal Institution, and a public celebration with a keynote speech from University of Surrey quantum physicist and broadcaster Jim Al-Khalili. "The UK and Ireland already have a globally important position in many areas of quantum research, with the UK, for instance, having established one of the world's first National Quantum Technology Programmes," explains Grinyer. "We will also be using the focus this year gives us to continue to make the case for the investment in research and development, and support for physics skills, which will be crucial if we are to fully unlock the economic and social potential of what is both a fascinating area of research, and a fast growing physics-powered business sector," he adds.

Quantum careers

With the booming quantum marketplace, it's no surprise that employers are on the hunt for many skilled physicists to join the workforce. And indeed, there is a significant scarcity of skilled quantum professionals for the many roles across industry and academia. Also, with quantum research advancing everything from software and machine learning to materials science and drug discovery, your skills will be transferable across the board.

If you plan to join the quantum workforce, then choosing the right PhD programme, having the right skills for a specific role and managing risk and reward in the emerging quantum industry are all crucial (see "Prepare for a future in the quantum workforce" p10). There are a number of careers events on the IYQ calendar, to learn more about the many career prospects for physicists in the sector. In April, for example, the University of Bristol's Quantum Engineering Centre for Doctoral Training is hosting a Careers in Quantum event, while the *Economist* magazine is hosting its annual Commercialising Quantum conference in May.

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Quantum 2.0 Alongside quantum computing, quantum science will have a global impact on industry, healthcare and the environment.

There will also be a special quantum careers panel discussion, including top speakers from the UK and the US, as part of our newly launched Physics World Live panel discussions in April. This edition of *Physics World Careers*, as you will have noticed, has a special quantum focus, and there'll also be a bumper, quantum-themed issue of the *Physics World Briefing* in June. The *Physics World* quantum channel (physicsworld.com/quantum) will be regularly updated throughout the year so you don't miss a thing.

Read all about it

IOP Publishing's journals will include specially curated content – from a series of Perspectives articles – personal viewpoints from leading quantum scientists – in *Quantum Science and Technology*. The journal will also be publishing roadmaps in quantum computing, sensing and communication, as well as focus issues on topics such as quantum machine learning and technologies for quantum gravity and thermodynamics in quantum coherent platforms.

"Going right to the core of IOP Publishing's own historic coverage we're excited to be celebrating the IYQ through a year-long programme of articles in *Physics World* and across our journals, that will hopefully show a wide audience just why everyone should care about quantum science and the people behind it," says Smith.

Of course, we at *Physics World* have a Schrödinger's box full of fascinating quantum articles for the coming year – from historical features to the latest cutting-edge developments in quantum tech. So keep your eyes peeled.

Tushna Commissariat is a features and careers editor of *Physics World*

Prepare for a future in the quantum workforce

Quantum experts **Abbie Bray**, **Araceli Venegas-Gomez** and **Mark Elo** give their advice for interviews, choosing the right PhD programme and managing risk and reward in the emerging quantum industry

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Great expectations The number and variety of quantum careers is expanding. Our experts explain what skills and qualifications you need in this burgeoning domain.

It's official: after endorsement from 57 countries and the support of international physics societies, the United Nations has declared that 2025 is the International Year of Quantum Science and Technology (IYQ).

The year has been chosen as it marks the centenary of Werner Heisenberg laying out the foundations of quantum mechanics – a discovery that would earn him the Nobel Prize for Physics in 1932. As well as marking one of the most significant breakthroughs in modern science, the IYQ also reflects the recent quantum renaissance. Applications that use the quantum properties of matter are transforming the way we obtain, process and transmit information, and physics graduates are uniquely positioned to make their mark on the industry.

It's certainly big business these days. According to estimates from McKinsey, in 2023 global quantum investments were valued at $42bn. Whether you want to build a quantum computer, an unbreakable encryption algorithm or a high-precision microscope, the sector is full of exciting opportunities. With so much going on, however, it can be hard to make the right choices for your career.

To make the quantum landscape easier to navigate as a jobseeker, *Physics World* has spoken to Abbie Bray, Araceli Venegas-Gomez and Mark Elo – three experts in the quantum sector, from academia and industry. They give us their exclusive perspectives and advice on the future of the quantum marketplace; job interviews; choosing the right PhD programme; and managing risk and reward in this emerging industry.

Quantum going mainstream: Abbie Bray

According to Abbie Bray, lecturer in quantum technologies at University College London (UCL) in the UK, the second quantum revolution has broadened opportunities for graduates. Until recently, there was only one way to work in the quantum sector – by completing a PhD followed by a job in academia. Now, however, more and more graduates are pursuing research in industry, where established companies such as Google, Microsoft and BT – as well as numerous start-ups like Rigetti and Universal Quantum – are racing to commercialize the technology.

While a PhD is generally needed for research, Bray is seeing more jobs for bachelor's and master's graduates as quantum goes mainstream. "If you're an undergrad

AUDIO Matthew Hutchings, chief product officer and co-founder of SEEQC digital quantum computing platform, speaks about the increasing need for engineering positions in this sector.

Henry Bennie

Abbie Bray "Theorists and experimentalists need to move at the same time."

No matter what you do in quantum, there are certain skills and experiences that can cross over into other parts of tech, other parts of science, other parts of business

who's loving quantum but maybe not loving the research or some of the really high technical skills, there's other ways to still participate within the quantum sphere," says Bray. With so many career options in industry, government, consulting or teaching, Bray is keen to encourage physics graduates to consider these as well as a more traditional academic route.

She adds that it's important to have physicists involved in all parts of the industry. "If you're having people create policies who maybe haven't quite understood the principles or impact or the effort and time that goes into research collaboration, then you're lacking that real understanding of the fundamentals. You can't have that right now because it's a complex science, but it's a complex science that is impacting society."

So whether you're a PhD student or an undergraduate, there are pathways into the quantum sector, but how can you make yourself stand out from the crowd? Bray has noticed that quantum physics is not taught in the same way across universities, with some students getting more exposure to the practical applications of the field than others. If you find yourself in an environment that isn't saturated with quantum technology, don't panic – but do consider getting additional experience outside your course. Bray highlights PennyLane, which is a Python library for programming quantum computers, that also produces learning resources.

Consider your options

Something else to be aware of, particularly for those contemplating a PhD, is that "quantum technologies" is a broad umbrella term, and while there is some crossover between, say, sensing and computing, switching between disciplines can be a challenge. It's therefore important to consider all your options before committing to a project and Bray thinks that Centres for Doctoral Training (CDTs) are a step in the right direction. UCL has recently launched a quantum computing and quantum communications CDT where students will undergo a six-month training period before writing their project proposal. She thinks this enables them to get the most out of their research, particularly if they haven't covered some topics in their undergraduate degree. "It's very important that during a PhD you do the research that you want to do," Bray says.

When it comes to securing a job, PhD position or postdoc, non-technical skills can be just as valuable as quantum know-how. Bray says it's important to demonstrate that you're passionate and deeply knowledgeable about your favourite quantum topic, but graduates also need to be flexible and able to work in an interdisciplinary team. "If you think you're a theorist, understand that it also does sometimes mean looking at and working with experimental data and computation. And if you're an experimentalist, you've got to understand that you need to have a rigorous understanding of the theory before you can make any judgements on your experimentation." As Bray summarizes: "theorists and experimentalists need to move at the same time".

The ability to communicate technical concepts effectively is also vital. You might need to pitch to potential investors, apply for grants or even communicate with the HR department so that they shortlist the best candidates. Bray adds that in her experience, physicists are conditioned to communicate their research very directly, which can be detrimental in interviews where panels want to hear narratives about how certain skills were demonstrated. "They want to know how you identified a situation, then you identified the action, then the resolution. I think that's something that every single student, every single person right now should focus on developing."

The quantum industry is still finding its feet and earlier this year it was reported that investment has fallen by 50% since a high in 2022. However, Bray argues that "if there has been a de-investment, there's still plenty of money to go around" and she thinks that even if some quantum technologies don't pan out, the sector will continue to provide valuable skills for graduates. "No matter what you do in quantum, there are certain skills and experiences that can cross over into other parts of tech, other parts of science, other parts of business."

In addition, quantum research is advancing everything from software to materials science and Bray thinks this could kick-start completely new fields of research and technology. "In any race, there are horses that will not cross the finish line, but they might run off and cross some other finish line that we didn't know existed," she says.

Building the quantum workforce: Araceli Venegas-Gomez

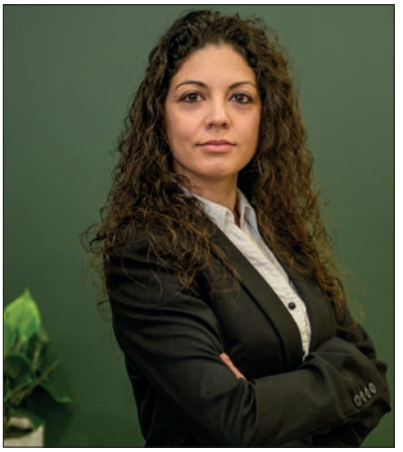
While working in industry as an aerospace engineer, Araceli Venegas-Gomez was looking for a new challenge and decided to pursue her passion for physics, getting her master's degree in medical physics alongside her other duties. Upon completing that degree in 2016, she decided to take on a second master's followed by a PhD in quantum optics and simulation at the University of Strathclyde, UK. By the time the COVID-19 pandemic hit in 2020, she had defended her thesis, registered her company, and joined the University of Bristol Quantum Technology Enterprise Centre as an executive fellow.

It was during her studies at Strathclyde that Venegas-Gomez decided to use her vast experience across industry and academia, as well as her quantum knowledge. Thanks to a fellowship from the Optica Foundation, she was able to launch QURECA (Quantum Resources and Careers). Today, it's a global company that helps to train and recruit individuals, while also providing business development advice for both individuals and companies in the quantum sphere. As founder and chief executive of the firm, her aims were to link the different stakeholders in the quantum ecosystem and to raise the quantum awareness of the general public. Crucially, she also wanted to ease the skills bottleneck in the quantum workforce and to bring newcomers into the quantum sector.

As Venegas-Gomez points out, there is a significant scarcity of skilled quantum professionals for the many roles that need filling.

AUDIO Araceli Venegas-Gomez, founder and CEO of QURECA, discusses her journey into the sector the gap between quantum information science and business.

Qureca



Araceli Venegas-Gomez "If you have a background in physics and business, everyone is looking for you."

This shortage is exacerbated by the competition between academia and industry for the same pool of talent. "Five or ten years ago, it was difficult enough to find graduate students who would like to pursue a career in quantum science, and that was just in academia," explains Venegas-Gomez. "With the quantum market booming, industry is also looking to hire from the same pool of candidates, so you have more competition, for pretty much the same number of people."

Slow progress

Venegas-Gomez highlights that the quantum arena is very broad. "You can have a career in research, or work in industry, but there are so many different quantum technologies that are coming onto the market, at different stages of development. You can work on software or hardware or engineering; you can do communications; you can work on developing the business side; or perhaps even in patent law." While some of these jobs are highly technical and would require a master's or a PhD in that specific area of quantum tech, there are plenty of roles that would accept graduates with only an MSc in physics or even a more interdisciplinary experience. "If you have a background in physics and business, everyone is looking for you," she adds.

From what she sees in the quantum recruitment market today, there is no job shortage for physicists – instead there is a dearth of physicists with the right skills for a specific role. Venegas-Gomez explains that graduates with a physics degree in many fields have transferable skills that allow them to work in "absolutely any sector that you could imagine". But depending on the specific area of academia or industry within the quantum marketplace that you might be interested in, you will likely require some specific competencies.

> Employers are looking for candidates who can show that they have been doing outreach and communication activities

As Bray also stated, Venegas-Gomez acknowledges that the skills and knowledge that physicists pick up can vary significantly between universities – making it challenging for employers to find the right candidates. To avoid picking the wrong course for you, Venegas-Gomez recommends that potential master's and PhD students speak to a number of alumni from any given institute to find out more about the course, and see what areas they work in today. This can also be a great networking strategy, especially as some cohorts can have as few as 10–15 students all keen work with these companies or university departments in the future.

Despite the interest and investment in the quantum industry, new recruits should note that it is still in its early stages. This slow progress can lead to high expectations that are not met, causing frustration for both employers and potential employees. "Only today, we had an employer approach us (QURECA) saying that they wanted someone with three to four years' experience in Python, and a bachelor's or master's degree – it didn't have to be quantum or even physics specifically," reveals Venegas-Gomez. "This means that [to get this particular job] you could have a background in computer science or software engineering. Having an MSc in quantum per se is not going to guarantee that you get a job in quantum technologies, unless that is something very specific that the employer is looking for."

So what specific competencies are employers across the board seeking? If a company isn't looking for a specific technical qualification, what happens if they get two similar CVs for the same role? Do they look at an applicant's research output and publications, or are they looking for something different? "What I find is that employers are looking for candidates who can show that, alongside their academic achievements, they have been doing outreach and communication activities," says Venegas-Gomez. "Maybe you took on a business internship and have a good idea of how the industry works beyond university – this is what will really stand out."

She adds that so-called soft-skills – such as demonstrating good leadership, teamwork and excellent communication skills – are very valued. "This is an industry where highly skilled technical people need to be able to work with people vastly beyond their area of expertise. You need to be able to explain Hamiltonians or error corrections to someone who is not quantum-literate and explain the value of what you are working on."

Venegas-Gomez is also keen that job-seekers realize that the chances of finding a role at a large firm such as Google, IBM or Microsoft are still slim-to-none for most quantum graduates. "I have seen a lot of people complete their master's in a quantum field and think that they will immediately find the perfect job. The reality is that they likely need to be patient and get some more experience in the field before they get that dream job." Her main advice to students is to clearly define their career goals, within the context of the booming and ever-growing quantum market, before pursuing a specific degree. The skills you acquire with a quantum degree are also highly transferable to other fields, meaning there are lots of alternatives out there even if you can't find the right job in the quantum sphere. For example, experience in data science or software development can complement quantum expertise, making you a versatile and coveted contender in today's job market.

Approaching "quantum advantage": Mark Elo

In 2023, IBM broke records by building the first quantum chip with more than 1000 qubits. The project represents millions of dollars of investment and the company is competing with the likes of Intel and Google to achieve "quantum advantage", which refers to a quantum computer that can solve problems that are out of reach for classical machines.

Despite the hype, there is work to be done before the technology becomes widespread – a commercial quantum computer needs millions of qubits, and challenges in error correction and algorithm efficiency must be addressed.

"We're trying to move it away from a science experiment to something that's more an industrial product," says Mark Elo, chief marketing officer at Tabor Electronics. Tabor has been building electronic signal equipment for more than 50 years and recently started applying this technology to quantum computing. The company's focus is on control systems – classical electronic signals that interact with quantum states. At the 2024 APS March Meeting, Tabor, alongside its partners FormFactor and QuantWare, unveiled the first stage of the Echo-5Q project, a five-qubit quantum computer.

Elo describes the five years he's worked on

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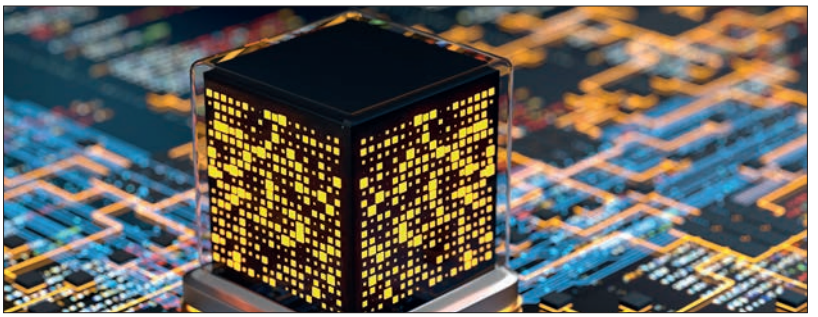

Risk and reward "The right technical skills will always allow you to switch industries if needed."

There are some geniuses in the world, but if they can't communicate it's no good in an industrial environment

quantum computing as a period of significant change. Whereas researchers once relied on "disparate pieces of equipment" to build experiments, he says that the industry has changed such that "there are [now] products designed specifically for quantum computing".

The ultimate goal of companies like Tabor is a "full-stack" solution where software and hardware are integrated into a single platform. However, the practicalities of commercializing quantum computing require a workforce with the right skills. Two years ago the consultancy company McKinsey reported that companies were already struggling to recruit, and they predicted that by 2025, half of the jobs in quantum computing will not be filled. Like many in the industry, Elo sees skills gaps in the sector that must be addressed to realize the potential of quantum technology.

Elo's background is in solid-state electronics, and he worked for nearly three decades on radio-frequency engineering for companies including HP and Keithley. Most quantum-computing control systems use radio waves to interface with the qubits, so when he moved to Tabor in 2019, Elo saw his career come "full circle", combining the knowledge from his degree with his industry experience. "It's been like a fusion of two technologies" he says.

It's at this interface between physics and electronic engineering where Elo sees a skills shortage developing. "You need some level of electrical engineering and radio-frequency knowledge to lay out a quantum chip," he explains. "The most common qubit is a transmon, and that is all driven by radio waves. Deep knowledge of how radio waves propagate through cables, through connectors, through the sub-assemblies and the amplifiers in the refrigeration unit is very important."

Elo encourages physics students interested in quantum computing to consider adding engineering – specifically radio-frequency electronics – courses to their curricula.

Transferable skills

The Tabor team brings together engineers and physicists, but there are some universal skills it looks for when recruiting. People skills, for example, are a must. "There are some geniuses in the world, but if they can't communicate it's no good in an industrial environment," says Elo.

Elo describes his work as "super exciting" and says "I feel lucky in the career and the technology I've been involved in because I got to ride the wave of the cellular revolution all the way up to 5G and now I'm on to the next new technology." However, because quantum is an emerging field, he thinks that graduates need to be comfortable with some risk before embarking on a career. He explains that companies don't always make money right now in the quantum sector – "you spend a lot to make a very small amount". But, as Elo's own career shows, the right technical skills will always allow you to switch industries if needed.

Like many others, Elo is motivated by the excitement of competing to commercialize this new technology. "It's still a market that's full of ideas and people marketing their ideas to raise money," he says.

"The real measure of success is to be able to look at when those ideas become profitable. And that's when we know we've crossed a threshold."

Katherine Skipper and **Tushna Commissariat** are features and careers editors of *Physics World*

Quantum innovation charges the technology roadmap

The mission of the US Quantum Economic Development Consortium (QED-C) is to enable and grow a robust quantum-based industry and supply chain. Executive director **Celia Merzbacher** tells Hamish Johnston how QED-C addresses gaps in quantum-related technologies and workforce capacity by encouraging collaboration between government, research and industry

Why is it important for the US and other countries to have a national strategy for quantum science and technology?
Quantum sensing, quantum networking and quantum computing technologies hold significant promise for improving national security, but also for their long-term economic and societal impacts. However, the field is still at a relatively early stage in terms of technology evolution. There's a clear requirement for advances in fundamental science, an activity supported by government funding in the main. It's also worth noting that quantum is what I call a "multi-type" endeavour. It's multidisciplinary, multiagency (in terms of government support), multisector and multinational. As such, progress will be accelerated through strategic, cross-cutting and coordinated investments in a broad research portfolio.

QED-C

Network leader Celia Merzbacher is executive director of QED-C, an industry-driven consortium managed by SRI International. With a diverse membership representing industry, academia, government and other stakeholders, QED-C is seeking to accelerate quantum R&D, technology innovation and commercial opportunities.

How should countries balance their national security requirements with the need for international collaboration and global supply chains in quantum technology?
It's understandable that national interests should play a role in controlling the flow of information in certain sensitive quantum use-cases – though, ultimately, any restrictions need to be implemented carefully and in partnership between like-minded countries. Right now, it feels premature to be overly restrictive. There's a broad understanding of the need for open sharing of information, R&D opportunities and science/engineering talent to encourage multidisciplinary collaboration between centres of excellence all over the world.

Is the current US effort in quantum science and technology well positioned?
Looked at from an input perspective, the US is faring well, with government investment in quantum R&D for 2022 running at around $900m – and compared with an aggregate per-annum global spend on quantum across government and private sector estimated at approximately $30bn. In terms of outputs as well, the US is shaping up competitively, registering the largest numbers of highly cited, high-impact scientific publications along with China.

Is there a danger of too much hype damaging the reputation of the quantum industry?
This is a key question and one that crops up often. There's certainly a lot of excitement and interest around the quantum sector, with growing levels of public and private-sector investment. Here at QED-C, we don't see evidence of what might be called a "bubble" – just researchers and companies within the emerging supply chain reporting steady progress on their development roadmaps while addressing a lot of tough technology and

Quantum technicians: scaling talent growth for industry

While efforts are underway to prepare students at the undergraduate, masters and PhD level for quantum engineering and scientist roles, there are few associate degree and specialist vocational education programmes geared specifically towards the training of "quantum technicians". That's the main take-away from Guide to Building a Quantum Technician Workforce, a new study from QED-C, a consortium of US and international stakeholders that aims to fast-track growth across the quantum industry supply chain.

Quantum technicians fulfil many key functions in quantum technology companies, including system and component fabrication, device assembly, characterization, testing, operation and maintenance. What's more, notes the report, demand for skilled technicians "is expected to grow as the industry continues its rapid development", with a pressing need to scale this section of the workforce in the near term.

A range of specialist domain knowledge and skills are commonly required for quantum technician roles – including experience with vacuum, cryogenic and optical systems, as well as programming and soft skills. Current hiring strategies often focus on recruiting candidates from adjacent technology sectors – microelectronics, semiconductor manufacturing and photonics among them – with in-house shadowing programmes to provide on-the-job training for new staff.

The QED-C report argues, however, for a "more coordinated approach specifically geared toward filling the quantum workforce pipeline" and, in turn, to increase productivity and commercial opportunities, especially within smaller companies.

Recommendations in the QED-C study include: defining the types of quantum technician roles and investing in marketing to build awareness about career trajectories; mapping of existing training programmes versus the knowledge, skills and abilities that quantum technicians need; and creating local partnerships between higher education, industry and the US National Laboratory system. The report also calls for the establishment of an accreditation programme for quantum technology curricula and extra cash for institutions focused on quantum training and education rather than research.

"Manufacturing of quantum systems has not yet scaled to high-volume production," the report concludes. "As such, many assume that demand for quantum technicians is low or non-existent. This is a common misconception – in fact, quantum technician roles are highly relevant in the experimental and prototype stages."

● *Guide to Building a Quantum Technician Workforce: Reskilling and Upskilling Recommendations to Prepare a Workforce of Quantum Technicians* is available on an exclusive basis to members of QED-C.

engineering problems along the way. In fact, organizations like QED-C have a significant role to play here in managing expectations. Chiefly, that means sharing credible, evidence-based data and metrics on progress so that diverse stakeholders – policy-makers, funding agencies, the investment community and industry – have a granular understanding of the state-of-the-art and where quantum technology is heading.

There's an acknowledged shortage of skilled workers in the quantum workforce worldwide. What skills are needed to bridge the gap?

There's a misconception that workers need to have a PhD – preferably in physics – to enter this field. That's absolutely not the case. Manufacturers and developers within the early-stage quantum supply chain are desperate for scientists, engineers and technicians – especially those with experience in a related field – for example, cryogenics, test and measurement, data science or circuit design. What's more, with targeted training and staff development, it's possible for mid-career professionals in related disciplines to pivot into a career in the quantum industry (see "Quantum technicians: scaling talent growth for industry", above).

One thing is clear: the quantum sector is brimming with opportunity for ambitious individuals, with a range of skills needed within hardware companies, software companies and, ultimately, the end-users of quantum technologies in key verticals like pharma, finance and healthcare.

We also need commercially minded technical sales people who understand how to fuel the nascent market for quantum applications. In this way, the quantum industry offers all sorts of pathways for talented scientists and engineers to evolve from mainstream technical roles into business development activities if they choose.

QED-C was originally launched as a US initiative but has since opened its membership to organizations from 36 like-minded countries. What's driven this shift?

Quantum R&D and technology innovation is happening on a global scale and certainly the US, at this time, does not have the sole leadership position or an enormous head start. We recognized from the outset – along with our federal government sponsors – that international partnerships would ultimately be fundamental to the success of the QED-C mission. Equally, our members are looking at a global opportunity when it comes to markets, customers, technology partners and even investors. Helping our members succeed along those coordinates is what we try to do every day at QED-C.

How should industry and government approach R&D on quantum computing given that it's unclear which platform technologies – superconducting circuits, ion traps, photonic processors or the like – will prove commercially viable?

For government, the focus is on precompetitive basic and applied research. That means prioritizing foundational hardware and software technologies, underpinned by theoretical understanding, experimental systems, device design and fabrication – and pushing along all of these research pathways simultaneously. On the industry side, meanwhile, companies across the supply chain need to progress as quickly as possible from the R&D lab towards sustainable revenues and long-run commercial applications.

Another area that needs to be strengthened is engagement with the end-users of quantum computing in all sorts of diverse industries – from quantitative finance and insurance to medicine, telecoms, advanced materials and the rest. Over time, there will be many more "quantum takers" than "quantum makers" and all those takers need to be setting up pathfinder teams now to figure out how their respective industries will be disrupted by quantum technologies.

● Listen to the full interview on the *Physics World* podcast channel: "Quantum science and technology thrives when industry and governments join forces".

Hamish Johnston is an online editor of *Physics World*. Additional reporting by **Joe McEntee**

Tackling England's physics teacher shortage

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Securing the future The shortage of specialist physics teachers is a growing problem facing schools and young people in the UK, but could the new teacher degree apprenticeships help?

The shortage of physics teachers in England has led the government to set up a new apprenticeship scheme that it hopes will help encourage more people into the profession. But with high workloads and low pay causing many teachers to quit, **Katherine Skipper** asks if this latest scheme will be enough to fix the issue

Very few world-changing physics breakthroughs happen in a classroom, but many of them started there. However, an increasing number of young people in the UK simply do not have access to a specialist physics teacher. In 2022 the number of physics teachers recruited in England was only 17% of the government's target, and the Institute of Physics (IOP) estimates that an additional 3500 teachers are needed to make up the shortage.

Hari Rentala, head of learning and skills at the IOP, says that in some areas, schools struggle to recruit a single specialist physics teacher. "This leaves young people at the mercy of a postcode lottery, with schools in socioeconomically disadvantaged areas more likely to suffer." It is no understatement to say that the future of the next generation of physicists is at stake.

The urgent need for more physics teachers is one reason why the Department for Education in England earlier this year launched a new recruitment pathway called "teacher degree apprenticeships" (TDAs). Physicists who want to become teachers currently have to do a degree followed by a postgraduate teaching qualification. TDAs are four-year

degrees, but students would spend only 40% of their time in university and the rest working in a school. Prospective teachers will therefore earn money as they study.

The vicious circle of shortages

Teaching is often described as a vocation – it is rewarding to instil a passion for physics in young people, but it isn't as well paid as many pathways available to physics graduates. According to the 2023 Science Teacher Survey, which was supported by the IOP and received more than 3700 responses from teachers and technicians, low pay is one of many barriers to recruitment and retention.

The challenge of recruiting enough physics teachers is made worse by the fact that almost half of new physics teachers leave within their first five years of qualifying. One reason for the high attrition rate is that in England it is common for physics teachers to also cover chemistry and biology despite not having specific expertise in those areas. "This has the potential to decrease job satisfaction and increase workload, especially for newly qualified teachers who may not have studied the other sciences for many years," says Rentala.

The situation is different in Scotland. Physics teachers there generally only teach physics, which leads to them staying far longer in the profession. Rentala says eight times as many physics teachers leave after the first two years in England compared with Scotland. Indeed, many physics graduates who do decide to become teachers in England end up training as maths teachers to avoid teaching subjects in which they do not have a specialism.

However, teacher retention is a UK-wide issue, with more than half of the respondents to the survey reporting that their school had a shortage of physics teachers. "This can leave physics teachers feeling isolated and – especially in their early years – without sufficient access to the informal subject-specific mentoring and support that most of us turn to when we begin our careers," Rentala says.

As a result of the overall shortage, physics teachers gravitate towards high-achieving schools in more affluent areas, which threatens to entrench regional and economic in-equality. In England, 70% of physics A-level students come from only 30% of schools. But will the new TDAs make a difference?

Alternative pathways

Charles Tracy, the IOP's senior adviser for learning and skills, thinks that TDAs are an efficient way to become a teacher. "Otherwise, they'd have to take a physics degree and learn lots of things that they would never otherwise use in their teaching." Depending on the course, apprentices might not learn content like, say, relativity and quantum mechanics, which generally do not appear on school syllabuses.

TDAs are due to start accepting applications later this year, with the first cohort of apprentices beginning their training in 2025, although it is not clear which universities will be offering the courses. Tracy, however, thinks that the scheme might particularly appeal to people who are already working in schools, such as teaching assistants or computer or lab technicians.

But TDAs will only ever be part of the solution. Geoff Barton, general secretary of the Association of School and College Leaders, says that while the principle behind the apprenticeships is good, the pilot scheme of 150 recruits will be a "drop in the ocean".

"The main event is the challenge that exists right now, and this involves the need for a laser-like focus on improving recruitment and retention – which must involve government action to improve pay, reduce workload and make the accountability system of Ofsted inspections and performance tables less punitive."

As well as supporting the apprenticeship scheme, last year the IOP submitted evidence to a parliamentary committee that recommended serious reforms to the physics curriculum in England. Rentala believes that ensuring that physics teachers only teach their specialist subject would tackle the high attrition of physics teachers by reducing workload and allowing teachers to focus on the topics that they are passionate about. But he adds that organizations like the IOP cannot do everything on their own. "This is a complex issue and one where the real step-changes can ultimately only be unlocked through government policy."

TDAs are four-year degrees, but students would spend only 40% of their time in university and the rest working in a school

Katherine Skipper is a features and careers editor of *Physics World*

How networking can bolster diversity in physics

Physicists who want to solve the world's great challenges don't just need deep technical expertise, but also excellent networking skills. **Claire Malone** explains that getting the most out of networking is all a question of practice – and providing those opportunities is key to increasing diversity in physics

Whether it's providing clean water around the world or designing spacecraft to monitor the impact of climate change, today's young people are keen to find solutions to the many challenges society is facing. That effort needs many different approaches, but studying physics undoubtedly increases the arsenal of tools a young person can use towards these aims.

However, what is often not taught in the physics classroom is that soft skills – such as networking and communicating your work – can be just as important for your career as getting your head around nuclear fusion or quantum mechanics. Not only that, but practising these skills is helpful for giving young people confidence in all areas of life – and in turn, promotes diversity in physics.

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Making connections Networking helps build collaborations, develop communication skills and encourage diversity.

Battling biases

Unfortunately some people's confidence in their scientific ability is diminished by the conscious and unconscious biases they constantly have to negotiate. Some are put off by misconceived ideas they are told about physics – such as it being a solitary field for anti-social "nerds". Others are denied the opportunity to study physics due to the prejudice and stereotypes that they experience because of who they are. Girls, for example, are often presented with the myth that physics is more suited to boys, while many young people are told that physics is not for the likes of them based on their ethnicity, sexual orientation, disability or social background.

The harmful and upsetting message that physics is not for women was reinforced very publicly in 2019 in a talk by Alessandro Strumia at CERN's first workshop on High Energy and Gender. He wrongfully argued that women are inherently less capable of physics research than men and that this supposed discrepancy is the main reason for the disparity between the genders in theoretical physics. If that wasn't enough, Strumia also claimed that the biases women face in physics actually work in their favour.

In reality, there is plenty of evidence to the contrary (*PNAS* **109** 16474; *Nature Chem.* **14** 1203; *PNAS* **111** 4403). For example, women in science, technology, engineering and mathematics (STEM) subjects are more likely to have their e-mails ignored when enquiring about potential PhD positions; are less likely to be awarded funding and grants; and need to have, on average, published three times more papers in top-tier journals than their male colleagues to secure the same job in academia. In addition, there is frequent harassment and bullying that forces some to leave science altogether.

The end result is that too many young people, especially young women, are made to feel that they can't do physics or that they don't fit in, and so they don't pursue their physics education.

It's a problem exacerbated by the lack of visible role models in physics that under-represented groups can identify with. As a report jointly published by the Institute of Physics (IOP), the Royal Astronomical Society and the Royal Society of Chemistry showed, young people are much more likely to study a STEM subject or pursue a STEM career if they can see someone they identify with, who has gone there first and who inspires them. How-

Five top tips for networking

Networking is often perceived as a scary dark art that only the most confident people can excel at. This is not true – it's just a matter of practice. Here are five tips to help you get the most out of networking.

1 You can't network if you're not there

It sounds simple, but the first thing is to show up. Departments, universities and organizations such as the Institute of Physics (IOP) put on many events where the opportunity to network arises. These can be department lectures, lunchtime talks, day conferences, careers events and more. Try to take up as many opportunities as possible to talk to people. Even if the occasion is not relevant to your interests, it can be good practice in networking. It's important to have the confidence that people will want to talk to you. Everyone there has the same goal of meeting new people. Be one of those people they meet.

2 "Who are you?" and "what do you do?"

An easy thing to practise before any networking opportunity is how you would describe yourself and your interests. Often the first questions people will ask are "who are you?" and "what do you do?", and answers to these can be easily prepared in advance. It's a good idea to have a roughly 30-second "pitch" describing yourself and your research and/or career interests. However, be aware that the people you speak to will have different backgrounds and you may need to tailor your pitch. For example, when I talk to particle physicists, I describe my PhD research in terms of quarks and supersymmetry, whereas when I am talking to scientists in other fields, I describe my research in terms of the question of the missing matter of the universe.

3 The give and take of a conversation

Remember that a conversation is a two-way process and take an active role in steering its flow so that it doesn't focus only on one person. Showing an interest in the people you are talking to and responding positively to them will help make a good impression and a connection.

4 Stay connected

To make sure your hard work doesn't go to waste, you will need a way to stay in touch with the people you meet. This can be on LinkedIn, via e-mail or through a professional social media account. You may also need a way to note down contact details as well as give your own – business cards can be very useful for this. Afterwards, make contact soon after the event to maintain that connection you have created. This doesn't have to be prolonged – it can just be saying how nice it was to meet somebody at the event and that you hope to talk again sometime soon.

5 Be aware of your online presence

Last, with the predominance of social media, it's important to be aware of your online footprint. Social media is a wonderful way to stay connected, but it also serves as a record attached to your name. Permanently removing information can be difficult so it's worth knowing what is publicly accessible and how easy it is for people to find when they look you up.

ever, finding such role models is often hard unless you are pointed in the right direction.

Networking for change

Among those trying to address the root causes of gender bias that permeate much of physics is the IOP, which realizes that a key strategy to remedy this bias is to promote a diverse range of role models to inspire school students. In fact, this was the motivation behind the event Networking with Leading Influencers in the Physics Community, held at Royal Holloway University of London, UK, in May 2023. It brought together school students, undergraduates and postgraduates with an all-women panel of physicists at different points in their careers and in different industries. I took part in this panel, in which we demonstrated that an interest in physical sciences opens doors to a career not only in academia but also a huge variety of other options. Journalism, patent law and mechanical engineering were represented on the panel too.

Events such as this don't just show the wide variety of career pathways you can go into with a physics degree. They also give students, in a supportive and informal setting, the chance to develop their networking skills, which are extremely useful but can only be learned by experience and yet are often overlooked during the early stages of higher education. Networking helps promote collaborations, build confidence in talking about your work, and exposes you to what else is happening in the field.

In addition, networking events like the one in May are invaluable for improving diversity in STEM. They give young people the chance to find role models who could have a positive influence on their entire careers. And by letting students see people with whom they identify working as successful physicists, such events combat stereotypes and show that people from a wide range of backgrounds can be scientists.

By listening to the career stories of physicists at these events, students also can see that science is not the solitary activity it's often portrayed as being. As the speakers made clear, pursuing a scientific career does not imply that you will focus solely on your chosen area of expertise to the exclusion of other disciplines. For example, experiments in my own field of particle physics involve many thousands of scientists and engineers from different disciplines working together on a daily basis. These lessons are often missed from the pages of physics textbooks.

Despite the obvious advantages of networking, it can feel scary or even in some way devious – almost a dark art. This an unhelpful and incorrect misconception that could hold some young people back in their careers. Sure, networking requires a certain level of confidence and practice, as with any skill. But by introducing students to networking situations early in their careers, we can show that it is just another skill that you can get good at if you practise hard enough.

The lesson that your career can be helped by chance conversations at conferences is much easier to impart through real-life stories than through, say, pamphlets from the careers office. We need to teach future physicists that if you want to solve humanity's greatest problems, then teamwork and reaching out to people from different backgrounds are as important as being able to model water supplies, launch rockets and do the all the technical stuff we traditionally think physics is all about.

Claire Malone is a science journalist based in London and a contributing columnist for *Physics World*, www.drclairemalone.com

Calling all physicists: you are vital for the green economy

James McKenzie examines the key messages of a new report on the green economy from the Institute of Physics, which puts the work of physicists front and centre in dealing with climate change

"Over the next quarter of a century the world will determine its fate more profoundly than at any time since the first industrial revolution. We are at a fork in the road." That's the sobering warning from the University of Birmingham nuclear physicist Martin Freer in the foreword to the recent *Physics Powering the Green Economy* report from the Institute of Physics (IOP), which publishes *Physics World*.

"One path," Freer adds, "sees us fail to transition away from fossil fuels, with runaway climate change. The other offers a future where we limit climate change and embrace clean technologies that transform the way we live, travel and work."

As the outgoing vice-president of science and innovation at the IOP, Freer is well aware that physicists are part of the solution. "Success at this juncture will be made possible by the green economy, built on sustainable, low-carbon technologies," he says. "Many of the technologies comprising the green economy have been driven, and will continue to be driven, by physics".

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Green future Climate change could be limited by encouraging the next generation of physicists to help develop technologies that transform the way we live.

Freer's thoughts are echoed in the report by Alok Sharma, the physicist who served as UK business and energy secretary in 2020/1 and was president of the United Nations COP-26 conference in Glasgow. Sharma calls climate change "the defining issue of our age", but believes it is an issue we can overcome "if we treat it with the urgency it demands". Physicists are ideally suited to the task, he thinks, but it must be properly co-ordinated by government departments.

The power of physicists

Physics Powering the Green Economy is a timely reminder of how physicists are – and have been – responsible for many green innovations ranging from low-energy computing and solar cells to wind power and the batteries that are needed to store energy drawn from new sources. If we want the green economy to develop, the report makes clear, it's vital to have a healthy physics ecosystem supporting these developments.

At this stage, I should declare that I was one of the many people who contributed to the report. It is mainly aimed at policymakers in the hope that they will engage more closely with the IOP and the physics community on the green economy. But given that climate change is such an important issue, I hope you don't mind me examining its key messages.

The report has some detailed and solid analysis about changes in how we generate and use energy. It points out, for example, that energy from renewables in the UK and Ireland has grown continuously since 1996 as a proportion of the overall energy we produce. Wind, in fact, now accounts for two-fifths of all electricity generated in the UK (up from barely a few per cent back then).

Another area covered in depth is the amount of physics research and development supported by the UK government and funding agencies. UK Research and Innovation (UKRI), in particular, has spent almost £2.25bn since 2005 on nuclear power,

renewable energy, energy storage, carbon capture plus hydrogen and other "alternative" fuels. Almost three-quarters (72%) of this money has gone into research classified as "core physics" and "strongly physics".

Businesses in the UK and Ireland are also playing a huge part in the green economy. According to the report, the UK's "low carbon and renewable energy" firms have a current turnover of £54bn. The IOP's analysis identifies, however, a much broader group of green-economy companies – spread geographically across the UK and Ireland – with a turnover of nearly £750bn. Given the UK's gross domestic product was £2.27 trillion in 2020, that's a significant percentage. Physics-powered green economy businesses are, it's clear, vital for international competitiveness and economic growth.

Truth in numbers

Perhaps the biggest surprise of the report is the sheer number, breadth and diversity of physics-based businesses focused on the green economy. The report includes 19 case studies but for each company highlighted there are many tens of others working in the same area. Clean energy alone has more than 1600 companies in the UK and almost 120 in Ireland. The combined turnover of businesses operating in at least one of the five key technology areas identified in the report is put at £744bn.

But will all this effort help the UK and Ireland to reach net-zero targets by 2050? Pragmatic and realistic as they are, 83% of physicists think we will miss that goal, according to a survey of IOP members that was carried out specially for this report. In fact, I can already hear some readers thinking, well, the report sounds worthy but it's all a bit pie in the sky.

However, it's worth remembering the statement released in early 2020 by BlackRock Inc – the world's largest investment manager – which said it would no longer invest in "thermal coal". The company, which manages around $7 trillion of funds, also said it will "drop" any company directors who fail to act on financial risks from climate change. When a company the size of BlackRock acts this way, you know things are for real.

There are many deniers, but to me, climate change is a modern-day version of a Pascal's wager. As the 17th-century French philosopher, mathematician and physicist Blaise Pascal argued, any rational person should live and act as though God exists. If God doesn't, you'll only have forfeited a few pleasures. But if God does exist, there's everything to be gained. Similarly, dealing with climate change will have huge benefits – from avoiding famine and mass extinctions, to minimizing drought and food shortages.

Physicists Powering the Green Economy is therefore worth reading as it sets out the central role that physics – and innovations from physics – can play in building a sustainable, internationally competitive green economy in the UK and Ireland. Physicists are well suited to the task given that it's a "systems challenge", in which various elements have to advance in a co-ordinated way without anyone losing sight of how each piece fits together.

The skills physicists have and the way they think are perfect for the green economy. Even if you're not involved in the sector yourself, you can help spread the message that physics is a great way for addressing climate change. Knowing that studying physics is key will surely inspire the next generation of young people looking to make their mark on the world.

James McKenzie is a physicist who helps bring new technology and products to market

How to survive a physics PhD

Achieving a doctoral degree, the highest academic qualification available, is a huge feat that can be a long and difficult journey. Having recently completed her own PhD in physics, **Pruthvi Mehta** shares her five top tips for surviving your doctoral studies

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More than research Achieving a PhD requires years of hard work, patience and determination.

I did it! I submitted my thesis, got through my four-hour-long viva, and passed with minor corrections. After four-and-a-half years, I finally got my PhD in physics from the University of Liverpool.

My thesis was on neutron tagging at Super-Kamiokande, a neutrino observatory in Japan. I first got interested in neutrinos towards the end of my undergraduate degree at Queen Mary University of London, so naturally I applied to do a PhD at universities with great neutrino physics groups. I was fortunate enough to be offered a place at Liverpool and began my doctoral studies in October 2018. The COVID pandemic during my PhD did present some challenges and extended the original length of my degree, but thankfully I submitted my thesis in March 2023.

After an educational journey as long (and sometimes arduous) as a doctoral degree, it is natural to wonder what you could have done differently to make the entire experience a little easier. So here I offer five tips for those on their PhD journeys that helped me during my studies – or that I wish I'd been told beforehand.

As no two routes to a doctoral degree are alike, my advice is naturally very broad. And rather than focusing simply on the work, I have also tried to suggest ways to bolster your motivation and wellbeing as well. No degree is worth harming your mental health, and given the dire stats regarding PhD student mental health in the UK, it is something that needs to be kept in mind.

With all this said, here are five ways to make the process a little smoother.

1 Work according to your energy levels – and don't constrain yourself to a routine if you feel you can't

At the start of my PhD I was told "treat it like a 9-to-5". That's all well and good, provided you don't have meetings outside these hours, conferences to attend, deadlines to meet, or experiments that need checking overnight – all of which you most likely will have in some form or another over the course of your studies.

Instead, something that worked for me (especially towards the end of writing my thesis) was working when I felt like it, when the momentum grabbed me. This naturally increased the closer to thesis submission: you are carried through by adrenaline from the looming deadline.

But this approach applies in earlier years as well – don't feel like you have to stick to the same routine every day. If your brain switches off a couple hours prior to 5 p.m., that's fine. I tended to fall into a slump in the afternoon, when I would switch off, leave the office, and work in the evening instead. And sometimes I would hit a wall mid-week, but felt a bit more motivated at the weekend.

There's no point over-exerting yourself when there are no fruits to be borne from your intellectual labour, and it's definitely not worth risking burnout over. You're allowed to make your own hours more than you would with a "conventional job", so make the most of it.

2 Make a continuous effort to connect with the field in general – not just strictly your own work

This is incredibly easy to preach, but a lot harder to practise. For many PhD students, the everyday minutiae of your research is a far cry from what attracted you to the field in the first place. And it sucks: it's hard to feel how, for example, the compiler error you've been stuck on for two days relates to what you enjoy learning about in physics and what drove you to your field of research. You can't see the wood for the trees, and you feel lost.

But remember, everything is connected. To see that, try to reinforce your surrounding knowledge and understanding of your field. Take part in journal clubs, read papers from other similar experiments, talk to others about their analyses, and find similarities to yours.

I'll admit, it's difficult to motivate yourself to do this. Why waste time reading stuff that won't fix the error you're stuck on? But I definitely wish I had done far more of it during my PhD. It's all about bringing yourself back to where your mind wants to engage with physics, and is ultimately more about motivation than results. This is how education and learning should be. But to a physics PhD student – who will have been through an education system more devoted to exams and results than instilling a love of learning – it is difficult to adjust to this mindset.

3 Start writing your theory and literature chapters as early as you can

This is, again, much easier said than done, but it does make the months leading up to thesis submission a lot easier. I started writing at the beginning of my third year, but I still feel as though I could have started earlier.

The benefit of getting this done earlier isn't just about making submission easier, but also about improving wellbeing and motivation as well. Say you're in a bit of a rut around some results analysis – fair enough, everyone hits stumbling blocks. Rather than trudging on, why not take a break and write some of your thesis theory chapter or prepare your literature review.

Not only will writing feel like you have done something concrete, which will boost your morale, it will also refresh your broader knowledge of the field. And while it may not be directly related to the analysis result you want to get out, sometimes thinking about something else gives your brain a chance to come up with new ideas. Plus, anything that counts towards your thesis is helpful, so don't hesitate to start writing early.

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Reviewing the literature It's a good idea to start writing your literature review and theory chapters as early as you can.

It's all about bringing yourself back to where your mind wants to engage with physics

4 Document when someone says something positive about your work

PhD students are often told that a key part of becoming a researcher is having faith in your own work and results, instead of relying too heavily on the opinions of others. If there is criticism, we're meant to not take it as a personal reflection of our abilities, and, in theory, we shouldn't. But the truth is, we're human and ultimately social creatures – and the human brain sadly remembers negative information more vividly than positive information. In a degree as challenging as a PhD, and a field filled with sometimes obstinate academics, you can hear and remember a lot more criticism than you do praise.

To counteract this, I started doing something that could be considered a little strange – I made a note every time a supervisor, a postdoc, a collaborator or even a friendly colleague in the office said something nice about my work. I wrote the comment down in a Word document, and when work got tough, I pulled it up to read through. Odd as it may seem, it helped to lift my mood when I needed it.

5 Treat your viva like a performance

An academic once told me that a viva "is about the ability to perform" and honestly, this was a great insight. Your viva is your chance to showcase your knowledge about your work and explain it to your examiners. Given the fact you've probably spent four or more years on it, you'll know it inside out.

Remember that you are allowed to take an annotated copy of your thesis in with you, so spend a couple of weeks going through it, annotating it thoroughly and learning the physics around what is written in your literature review. You could be asked about anything in the broader field, so pull out your previous degree notes and brush up on the (relevant) basics. If you're asked a question you don't immediately know the answer to, take a minute or so to think, and vocalize this thinking process so your examiners can maybe guide you to an answer.

Waiting for the viva is much scarier than the viva itself, so try not to fret or stress about it too much. Sure, that's once again easier said than done, but remember nobody knows your thesis and PhD better than you, and those few hours in a viva will be over before you know it. Doing a PhD is far from easy, but trust me when I say that it'll all work out.

Pruthvi Mehta is a contributing columnist for *Physics World* and a patent scientist specializing in software and AI at EIP

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It's an incredibly exciting time at AWE. We're in the early stages of a significant programme to design and produce a replacement warhead for the UK's continuous at sea deterrent. We're also going through an important infrastructure programme, delivering a cutting-edge, sustainable environment for the future. We offer our people a competitive salary and generous annual leave allowance, amongst other great benefits. We also work a nine-day fortnight, giving you every other Friday off to recharge your batteries and do more of what you love outside of work.

Training and development

Our teams have a strong blend of experienced professionals and new, hungry-to-learn talent at the very start of their career journeys, which gives us a real recipe for success. Our professional development programmes – from everyday mentoring, to support in gaining an AWE-funded professional registration – are opening new doors to opportunities for us as a business and, most importantly, for our people.

Graduate schemes

Evolve, our flagship graduate programme, consists of rotational placements designed to provide you with technical knowledge and expertise across several disciplines. We offer dedicated pathways within Engineering; Science; Corporate & Operations; Environment, Safety, Health & Quality; Project Management; and Finance. You will have access to a wide network of support and guidance throughout your time on the Evolve programme, including a dedicated line manager, an Evolve pathway lead, a "buddy" from a previous graduate cohort, and a supervisor within each of your placements.

What we are looking for

If you're passionate about learning and looking to advance or kick-start your career, it's likely we've got an opportunity for you. We're actively recruiting across our entire business, including our award-winning Early Career programmes for apprentices, undergraduates and graduates. By blending the minds and skills of experienced colleagues with those just starting out on their career journeys, we're building a diverse workforce where everyone can benefit from each other's unique perspectives.

Profile can be viewed at
physicsworldjobs.com

LOCATION
Reading, UK

NUMBER OF EMPLOYEES
c.8000

MAIN AREAS OF RESEARCH
Nuclear defence, nuclear forensics, radiation detection, plasma physics, hydrodynamics, high-performance computing, materials science

POSITIONS RECENTLY RECRUITED FOR
Computational physics, criticality scientists, experimental physics, radiation science, high-performance computing, radiation detection

PRE-REQUISITES
Must be a British national and have resided in the UK for 10 years for our science and engineering roles

HOW TO APPLY
Please visit our website **www.awe.co.uk/careers** for further information

CONTACT
AWE plc
Aldermaston
Reading
Berkshire RG7 4PR
UK
Tel +44 (0)118 981 4111
www.awe.co.uk

AWERIAN

Role: **Consultant Scientist / Engineer**
Location: **Cambridge, UK**
Salary: **Competitive + excellent benefits**
Contract: **Permanent**

Awerian is a high-tech research and development consultancy working within the UK defence and security industries. Our core activities span research and development within Science and Technology and are complemented by broader engineering skills in the creation of bespoke designs for our customers.

Founded on the deep connections between science and technology, Awerian assembles dynamic teams of research scientists and development engineers across multiple disciplines to meet client needs. These teams innovate and adapt to invent new solutions to hard technical challenges, expanding client's capabilities, pushing the boundaries of what is possible and forging the path to new technologies. As a scientist at Awerian, you will use your deep scientific insight and research skills to shine light on the hardest problems, exploring the art of the possible and inventing new solutions. You will design investigations to test and develop your ideas all the way from high-risk, high-reward, proof of concept investigations to fully functional operational prototypes. You will see the concepts you enable have direct impact on the safety of the UK and its citizens. You will work with and lead expert expert multidisciplinary teams delivering cutting-edge technology to our clients.

We are keen to hear from candidates with experience and / or background in the following areas:

- Quantum technology
- Artifical intelligence/machine learning
- Finite element simulation
- Semiconductor physics / device design
- Complex signal processing and classification
- Research vision and leadership
- Technical communication, particularly academic proposals and research reports

Other areas of interest to Awerian include:

- Cyber security
- Electronic warfare
- Autonomous systems
- Electromagnetics
- Mathematical analysis
- Operational analysis
- Remote sensing
- Novel sensor technologies

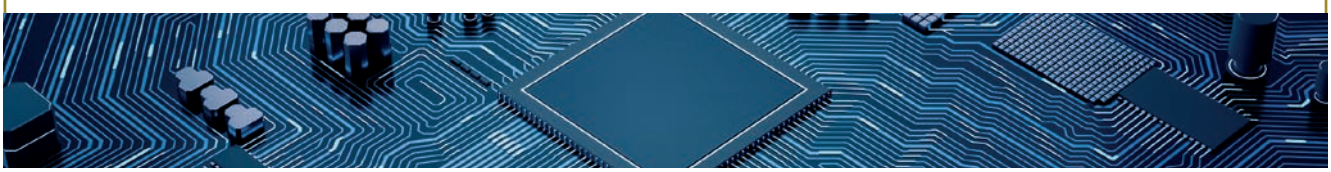
Driven by the needs of our clients, Awerian is growing rapidly, making this a great time to join our multi-disciplinary team. Supported by our team of experts, you will be part of building on our successful track record and develop your career at the cutting edge of technology. Our collaborative and flexible working environment will enable you to broaden your technical skills whilst retaining and deepening your subject area expertise.

You will apply your research and problem solving skills to real-world challenges, breaking complex ideas down into tractable components, facilitating the development of novel technologies and solutions based on strong fundamental scientific principles.

We would like to hear from you if you are an experienced scientist or research engineer already working in industry, academia, or as a consultant. We are also interested in post docs, and those with experience of teaching, supervising students, writing grant proposals or leading projects who may be looking for their next challenge outside of the academic field.

Please note: You will need to be eligible for UK Security Clearance. This role is not eligible for the UKVI visa sponsorship scheme.

awerian.net



AWERIAN

Awerian provides research and development services that extend and enhance the ability of the UK to defend itself and protect the future prosperity of its citizens. This encompasses ideas generation to address challenging problems, rapid design and implementation of technology demonstrators, through to complete product design and transfer to manufacture.

Why work for us

Awerian is no ordinary research and development consultancy. We are part of TTP Group, which is an employee-owned trust. With little hierarchy, there are no corporate hoops to jump through; this, along with our flat structure, encourages mutual support, teamwork and innovation. It also creates unique opportunities to develop skills in project leadership, client management and a variety of technological work, problem solving and innovation.

Training and development

Awerian consultants follow their own path, not a one-size definition of progression, our learning and development is centered around the individual. You follow the direction that you're passionate about. We are also employee-owned. This means that we all have a say in our future and we have the freedom to do the right thing by our clients, employees and business.

Graduate recruitment

We recruit a cohort of graduates, post-graduates, post-doctoral and early careers annually. Early careers joiners are a consultant on day one, working alongside experienced colleagues on client projects.

What we are looking for

We are continuing our growth through 2025 and are looking for exceptional technical talent. Our open roles are on our website and if you do not find a role that fits your skillset and are interested in working with us, please submit your CV to the Expression of interest role to connect with us.

Profile can be viewed at **physicsworldjobs.com**

LOCATION
Cambridge, UK

NUMBER OF EMPLOYEES
Awerian: 45+
TTP Group: 450+

MAIN AREAS OF RESEARCH
Physics, electronics, cyber, software, engineering, artificial intelligence/ machine learning

POSITIONS RECENTLY RECRUITED FOR
Physicist, electronics engineer, software engineer, artificial intelligence/machine learning engineer, firmware mechanical engineer

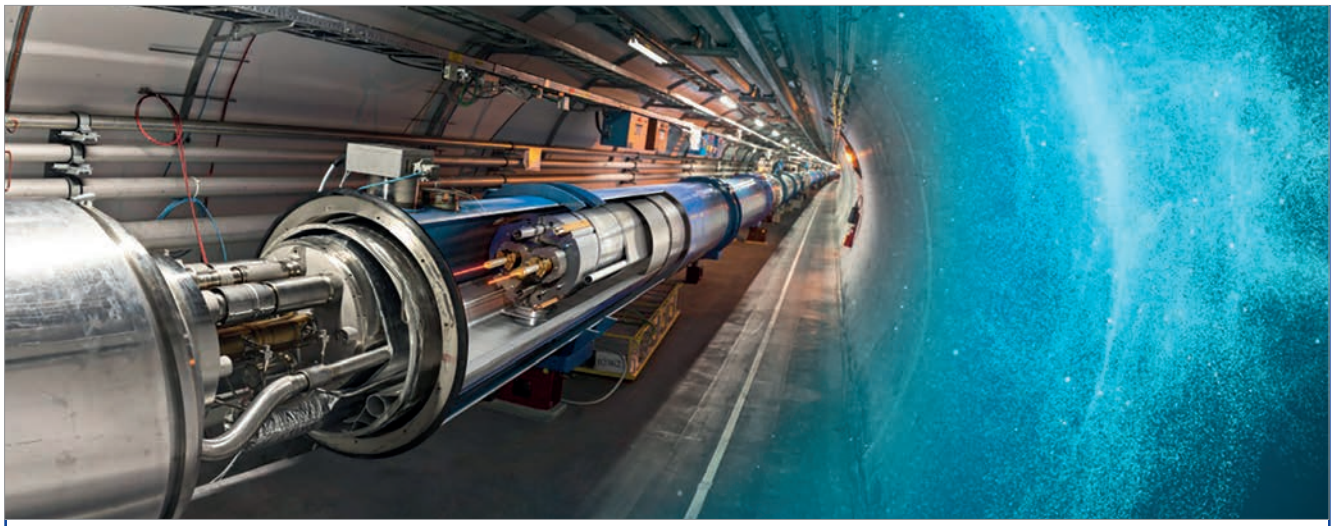
DESIRED DEGREE DISCIPLINES/CLASS
Physics, mathematics, other physical science, or engineering with a postgraduate degree in physical science. Excellent academic track record required

PRE-REQUISITES
Eligible for UK security clearance

HOW TO APPLY
Via **awerian.net/careers**

CLOSING DATE
All year round

CONTACT
Awerian Ltd
TTP Campus
Cambridge Road
Melbourn SG8 6HQ
UK
Tel +44 (0)1763 262626
E-mail recruitment@awerian.net
awerian.net



Hundreds of fields, thousands of people, millions of followers. Experienced or not, CERN could be your next opportunity.

Take part!

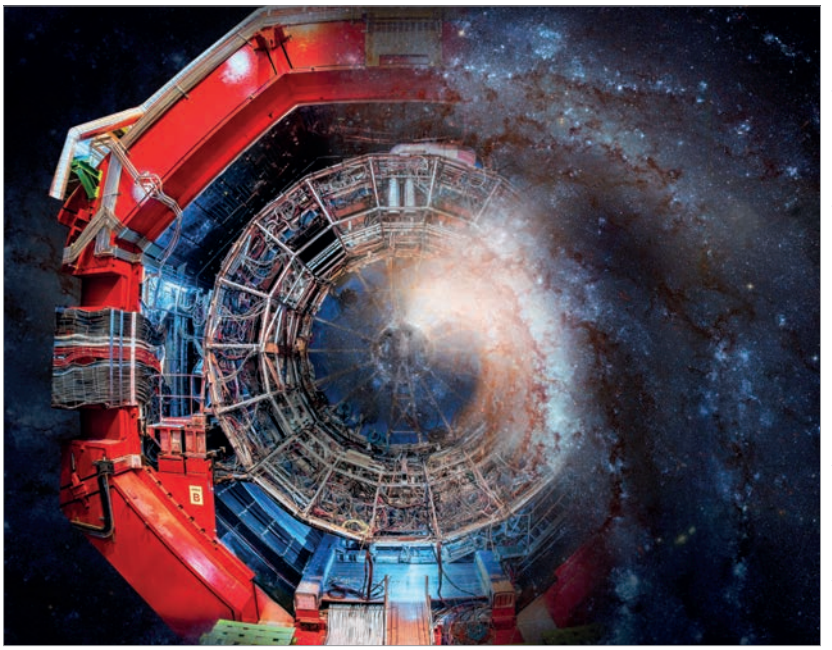
We like building things and breaking things. We like talking about the universe and particles, but we also like a bunch of other things. From mechanics, data science, software engineering, international relations, firefighting to our plans for a weekend in the mountains and lakes. We like people like us, and we love people that are not like us. Experienced or not, let's meet and make CERN a place like nowhere else on Earth.

CERN (European Laboratory for Particle Physics), located in Geneva, Switzerland, is one of the world's largest and most respected centres for scientific research.

A unique opportunity to develop your career, where every kind of thinking is welcome.

Apply now

Join CERN's technical, engineering, or administration teams in a wide range of fields. Take part!



At CERN, physicists and engineers use the world's largest and most complex scientific instruments to study the basic constituents of matter – the fundamental particles – to probe the underlying structure of the universe.

Working at CERN

CERN is a truly unique organization. A genuine collaboration between countries, universities and scientists, driven not by profit margins, but by a commitment to create and share knowledge. At CERN, students, recent graduates and experienced professionals work together to push for immense scientific discoveries, answering some of life's most complex questions and advancing the boundaries of human knowledge. People are free to work creatively and to trust in, and rely on, their colleagues across the organization. History is being made at CERN – and the excitement is tangible, inspiring, overwhelming at times. It is the only place in the world where you can do this work in this way.

Why work for us

Today, CERN employs more than 2500 people, and if you visit us you will find more than 2500 different reasons why CERN is such a great place to work. Six key reasons that we believe will make you love working here are: challenge, purpose, imagination, integrity, collaboration and quality of life.

Student and graduate schemes

CERN technical and administrative internships and graduate schemes offer international students and recent graduates the opportunity to work with world-class scientists and engineers on cutting-edge research in particle physics, computational science, life sciences, engineering, international relations, and more. Whichever route you take, it will be an extraordinary experience.

What we are looking for

To conduct experiments of this scale and importance, CERN needs people from various career levels and with a wide range of abilities, skills and competencies. We have job opportunities for students, graduates and experienced professionals, from apprenticeships to PhDs (and beyond). Whatever your background, field of interest or diploma level, CERN could be the place for you.

Profile can be viewed at **physicsworldjobs.com**

LOCATION
Geneva, Switzerland

NUMBER OF EMPLOYEES
2500+ staff members; several hundred on graduate and student programmes

POSITIONS RECENTLY RECRUITED FOR
Computing engineer, radiofrequency engineer, process operator in cryogenics, web developer, mechanical engineer, administrative assistant, system administrator, power electronics engineer, scientific writer, applied physicist and many more!

DESIRED DEGREE DISCIPLINES/CLASS
From apprenticeship to PhD in a wide variety of domains

HOW TO APPLY
Apply online at **careers.cern**

CLOSING DATE
All year round

CONTACT
CERN
Esplanade des Particules 1
1211 Geneva 23
Switzerland
Tel +41 22 76 63 786
E-mail recruitment.service@cern.ch
careers.cern

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We look forward to meeting you at an upcoming conference. Apply for one of our conference travel grants for full financial assistance with conference pass, travel, hotel and food.

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CITADEL | CITADEL Securities

Citadel is one of the world's leading alternative investment managers. We manage capital on behalf of many of the world's pre-eminent institutions. We seek the highest use of investor capital to deliver leading results and contribute to broader economic growth.

Citadel Securities is a leading global market maker and next-generation capital markets firm. We combine deep trading acumen with cutting-edge analytics and technology to deliver liquidity to the world's most important financial institutions – while helping shape tomorrow's markets.

Why work for us

Our culture of achievement invites the brightest minds in science. As a result, we have some of the most talented and accomplished researchers in the world working alongside our investment professionals, traders, and engineers.

Through discussion, debate and collaboration, we continue to outdo what's been done before. We're empowered to test our ideas and develop commercial solutions that drive real impact. Compute power, sophisticated analytics, modern tech stacks, and other dedicated resources enable us to put our best ideas into action.

Training and development

For new hires, we take an apprenticeship approach characterized by on-the-job learning: no prior finance experience required. We provide a robust onboarding and training programme to build skills that will prepare you for success now and in the future. Our early careers experience provides strong mentorship and a clear development plan.

What we are looking for

Our quantitative researchers come from diverse fields of physics as the markets present rich data, complex problems and fast feedback. We treat market problems as scientific questions, and our quants can quickly see how the markets validate or refute their thinking. They excel at finding creative connections in the complexity of market data and thinking critically. Iterating from multiple angles, they observe patterns and form hypotheses. When the data supports a hypothesis, we build out large-scale strategies to implement the idea.

Profile can be viewed at
physicsworldjobs.com

LOCATIONS
London, UK; Miami, New York, US; and Hong Kong

NUMBER OF EMPLOYEES
Citadel: 3100
Citadel Securities: 1700

POSITIONS RECENTLY RECRUITED FOR
Quantitative research, quantitative development, software engineering, quantitative trading

PRE-REQUISITES
Eligible to work in the US, UK, EU or Hong Kong

HOW TO APPLY
View open roles and apply online
www.citadelsecurities.com/careers/open-opportunities
www.citadel.com/careers/open-opportunities

CLOSING DATE
All year round

CONTACT
Citadel | Citadel Securities
120 London Wall
London EC2Y 5ET
UK
Tel +44 (0)20 7645 9700
www.citadel.com
www.citadelsecurities.com

Department of Physics

香港城市大學
City University of Hong Kong

City University of Hong Kong is a dynamic, fast-growing university that is pursuing excellence in research and professional education.

As a publicly funded institution having nine colleges/schools, the University is committed to nurturing and developing students' talents and creating applicable knowledge to support social and economic advancement.

Presidential Assistant Professors Scheme (PAP Scheme)

A new initiative of the City University of Hong Kong (CityUHK) for attracting top global talents and fostering a long-term career development of young scholars at CityUHK. The scheme aims to provide a competitive platform for attracting exceptional young researchers from diverse academic backgrounds with the potential to become world-class scholars and academic leaders at CityUHK.

Global Research Assistant Professors Scheme (GRAP Scheme)

A pioneering initiative at the City University of Hong Kong (CityUHK) that is dedicated to cultivating and empowering promising early-career researchers. Through the Scheme, young scholars will be provided with valuable opportunities to advance their research endeavors by closely working with CityUHK faculty members and Distinguished Visiting Professors.

The PAP and GRAP Schemes are managed by the Office of the Vice-President (Talent and International Strategy). Interested parties are encouraged to contact **vpti@cityu.edu.hk** for enquiries.

City University of Hong Kong is an equal opportunity employer and we are committed to the principle of diversity, Personal data provided by applicants will be used for recruitment and other employment related purposes.

#62 World University Rankings 2025

#10 Asia University Rankings 2025

#1 World's most international university

Department of Physics
香港城市大學
City University of Hong Kong

CITY UNIVERSITY OF HONG KONG (CITYUHK): DEPARTMENT OF PHYSICS

CityUHK is a young, fast-growing research university. The Department of Physics was founded in 2017, building on the outstanding tradition of the former Department of Physics and Materials Science. The last Research Assessment Exercise conducted by the Research Grants Council of Hong Kong, ranked CityUHK's physics second in Hong Kong.

Why work with us

The department aspires to become the leader in the Asia-Pacific region. Our existing faculty conducts world-class research, and our teaching curriculum is internationally benchmarked. Hong Kong, Asia's gateway to the world, provides excellent postgraduate student support, attracting top students from China, south-east Asia, and elsewhere in the world. As a truly international city, Hong Kong offers a unique lifestyle where East meets West, tradition meets contemporary, and mountains meet the ocean. Our compensation package is internationally competitive and commensurate with experience.

Training and development

Incoming faculty will have a major role to play in shaping the future of the department. Generous support is provided to successful candidates, allowing them to quickly set up research groups. International collaboration is strongly encouraged, with funding support available at all levels: national, university, college and department. The Greater Bay Area initiative – which aims to transform the Pearl River region encompassing Hong Kong, Macau and nearby cities in Guangdong, to an international centre of innovation – offers unparalleled opportunities for new researchers to excel.

What we are looking for

We are looking for candidates with a strong research record and promising teaching ability, with the goal to establish a world-class research programme. Applicants of all experience levels are welcome. Exceptional young talents eligible for competing for the Presidential Assistant Professors Scheme are particularly encouraged to apply. An initial appointment will normally be made on a fixed-term contract; the appointee can apply for substantiation or tenure during the second contract. Outstanding candidates can be appointed at higher ranks with tenure. Applicants in underrepresented groups are strongly encouraged to apply.

Profile can be viewed at
physicsworldjobs.com

LOCATION
Hong Kong

NUMBER OF EMPLOYEES
100

RESEARCH AREAS FOR RECRUITMENT
Theoretical and computational physics:
- High-energy physics/astrophysics/cosmology
- Machine learning/first-principles calculations/large-scale simulations

Experimental physics:
- Quantum materials' synthesis, particularly with expertise in single crystal growth

DESIRED DEGREE DISCIPLINES/CLASS
A PhD in physics or a related field

HOW TO APPLY
For further details, visit **www.cityu.edu.hk/hro/en/job/current/academic.asp?ref=uac-a460**

CLOSING DATE
All year round

CONTACT
Department of Physics
City University of Hong Kong
Tat Chee Avenue
Kowloon
Hong Kong
Tel +852 3442-9140
E-mail phy.head@cityu.edu.hk
cityu.edu.hk/phy

Elekta

Hope for everyone dealing with cancer.

At Elekta, we are driven to deliver cutting-edge, precision radiation therapy, to openly collaborate and help clinicians provide the best possible life outcomes for every patient.

We don't just build technology, we build hope.

elekta.com

LADXX220916d

A leader in precision radiation therapy, Elekta is committed to ensuring every patient has access to the best cancer care possible. We collaborate with customers to meet evolving patient needs, improve outcomes and bring hope to those dealing with cancer. We've been working openly and proactively with clinicians and our partners for almost half a century to advance precision radiation therapy and meet continuously evolving patient needs – no matter where they are in the world. This includes our investment in making our cutting-edge solutions broadly available to the millions of people around the world with limited access to cancer care. To us, it's personal, and our global team of 4700 employees combines passion, science and imagination to profoundly change cancer care.

Why work for us

Our treatment solutions and oncology informatics portfolios are designed to enhance the delivery of radiation therapy, radiosurgery and brachytherapy, and to drive cost-efficiency in clinical workflows. At Elekta, you will have the opportunity to work with a complex range of technologies including radiation physics, X-ray and MR imaging, software, electronics and mechanical systems. In addition, we also have expertise in manufacturing, logistics, product management, procurement, technical training and many other disciplines that can fulfil your career aspirations.

Training and development

At Elekta we expect every employee to want to do their best work and take responsibility for the development of their career. We offer different routes for development – from product and technical training, to attendance of scientific workshops and conferences – as well as personal-development programmes to enhance effectiveness and develop leadership skills. Employees benefit from a network of coaches and mentors and are encouraged to achieve industry-recognized qualifications (such as CEng, CPhys).

Graduate schemes

Elekta's Graduate Scheme is an excellent opportunity for recent physics and engineering graduates. The programme offers a range of rotations that allow graduates to learn about various areas of the company. Additionally, Elekta supports career development via the membership of professional bodies such as IOP, IET and IMechE.

What we are looking for

We are looking for motivated scientists and engineers with strong problem-solving skills and the ability to contribute in multidisciplinary teams. Roles will often offer interaction with our customers, healthcare professionals and research institutions, therefore we require excellent communication skills. Elekta solutions encompass the broad spectrum of disease management. Diverse and exciting employment opportunities are available in many areas. If this sounds like the kind of organization you'd like to become a part of, we want to hear from you.

Profile can be viewed at
physicsworldjobs.com

LOCATIONS
Main offices in the UK, Sweden, the Netherlands, China and the US

NUMBER OF EMPLOYEES
4700

POSITIONS RECENTLY RECRUITED FOR
We recruit for a variety of positions across our business – from research and development, through manufacturing and supply, to customer management, sales and service

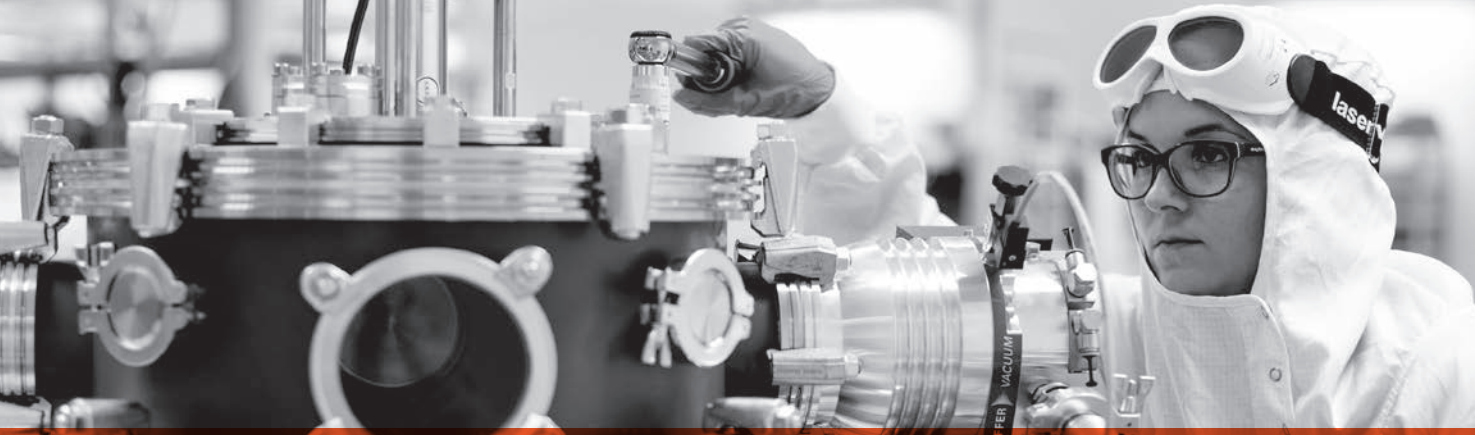
DESIRED DEGREE DISCIPLINES/CLASS
Undergraduate or postgraduate degree in medical physics, accelerator physics, imaging, mechanical engineering, electronics, software engineering and system engineering, or relevant experience. Some technical roles may require professional qualifications

PRE-REQUISITES
Eligibility to work in the job's location is preferred

HOW TO APPLY
Please visit **elekta.com/careers**

CLOSING DATE
All year round

CONTACT
Elekta Limited
Cornerstone
London Road
Crawley RH10 9BL
UK
Tel +44 (0)1293 544 422
E-mail info@elekta.com
elekta.com



JOIN US!

The future is in laser technologies

The ELI Beamlines Facility is a leading laser research centre and part of ELI (Extreme Light Infrastructure) pan-European Research Infrastructure hosting the world's most intense lasers. ELI provides unique tools of support for scientific excellence in Europe. ELI Beamlines developed and operates four leading-edge high-power femtosecond laser systems reaching unprecedented intensities.

The ELI ERIC is a specific legal form designed to facilitate the establishment and operation of Research Infrastructures of European interest. ERICs are participated by States and international organisations as members. As a main statutory mission, ELI ERIC is responsible for making the ELI Facilities available to the scientific community as a single international organisation, with unified governance and management.

The Czech Republic hosts the ELI ERIC statutory seat in Dolní Břežany, in the South of Prague, at the ELI Beamlines facility.

Our research groups are expanding and recruiting physicists and engineers.

In our team we therefore have the following positions available:

- **Junior Scientist**
- **Senior Scientist**
- **Laser Physicist**
- **Junior Engineer**
- **Senior Engineer**
- **Technician**
- **Mechanical Designer**
- **Control System Specialist**
- **Safety Engineer**
- **Optical Engineer**
- **X-ray Scientist**
- **Opto-mechanics**

For more information see our website **www.eli-beams.eu** and send your application, please.

eli

ELI Beamlines is part of the European ELI laser centre, the world's first international laser facility. ELI Beamlines is open to an international and interdisciplinary user community from academia and industry. Mandated by the international scientific laser community and implemented in the Czech Republic, Hungary and Romania, ELI drives international laser research and laser-based applications to new frontiers, and fulfils important missions for regional socio-economic development.

About us

The main mission of ELI Beamlines is to provide a user-oriented infrastructure for performing revolutionary scientific experiments across many different disciplines. It combines advanced synchronized ultra-intense short-pulse lasers with secondary sources of particles and X-rays.

The ELI Beamlines facility provides research opportunities at a number of world-class secondary sources, each one driven by ultra-intense lasers. These secondary sources, partially based on entirely new concepts, produce pulses of radiation and particles of the highest intensity and beam quality, including electromagnetic radiation over a broad spectral range and charged particles such as electrons, protons and ions. These will enable a wealth of novel applications.

The ERIC is a specific legal form designed to facilitate the establishment and operation of research infrastructures of European interest. ERICs are participated by States and international organizations as members. As a main statutory mission, ELI ERIC is responsible for making the ELI facilities available to the scientific community as a single international organization, with unified governance and management.

The Czech Republic hosts the ELI ERIC statutory seat in Dolní Břežany, in the South of Prague, at the ELI Beamlines facility. A second facility, ELI-ALPS, is hosted by Hungary in Szeged. The Czech Republic and Hungary are joined by Italy and Lithuania as founding members, while Germany and Bulgaria are founding observers. A third ELI facility is under construction in Romania in the field of nuclear photonics and is expected to complement the current ELI ERIC facilities in the future. More information can be found on the ELI ERIC websites.

Why work for us

ELI Beamlines brings together people from all over the world. If you want to participate in the largest laser research project in the world, apply through the offer of employment at www.eli-beams.eu. We are interested in people of various professions and specializations. We can offer interesting and challenging work, dedicated training, plus the chance to work with smart people in a pleasant working environment.

The future is in laser technologies. Are you interested? Join us!

Profile can be viewed at
physicsworldjobs.com

LOCATION
Czech Republic

NUMBER OF EMPLOYEES
350

POSITIONS RECENTLY RECRUITED FOR
Scientists, engineers, PhD students and technicians

DESIRED DEGREE DISCIPLINES/CLASS
From apprenticeship to PhD in a wide variety of domains

PRE-REQUISITES
Eligible to work in the EU

HOW TO APPLY
Apply online at **www.eli-beams.eu**

CLOSING DATE
All year round

CONTACT
ELI Beamlines
Za Radnicí 835
Dolní Břežany
Czech Republic 252 41
Tel +420 601560322
E-mail jana.zeniskova@eli-beams.eu
www.eli-beams.eu

ESRF
The European Synchrotron

JOIN THE WORLD'S MOST PIONEERING SYNCHROTRON LIGHT SOURCE

The ESRF – the European Synchrotron - is a not-for-profit research institute situated in the heart of the French Alps. Staff from 38 different countries work together to advance science and address societal challenges.

WE ARE RECRUITING

SCIENTISTS, ENGINEERS, TECHNICIANS, MANAGERS, POSTDOCS, STUDENTS, ADMINISTRATIVE STAFF

The ESRF operates the world's first 4th generation high-energy synchrotron, the Extremely Brilliant Source (EBS). It is a centre of excellence for fundamental and innovation-driven research in condensed and living matter science. The ESRF is an international cooperation between 20 partner countries.

We offer competitive salaries and a substantial benefits package.

Apply online

esrf.fr
in esrf_the europeansynchrotron

The ESRF is a landmark for fundamental and innovation-driven research, providing scientists from all over the world with the most brilliant X-rays to reveal the structure of materials and the mechanisms of life, down to atomic resolution.

Why work for us

For more than 30 years, the ESRF has enabled major scientific breakthroughs in the understanding of living and condensed matter. The Extremely Brilliant Source (EBS), the ESRF's 4th generation high-energy synchrotron, is opening new vistas for X-ray science. EBS provides a growing community of scientists with unique facilities to tackle the complex global challenges facing our society.

As a leader in the field of synchrotron science and technology, scientific and technical interdisciplinarity are at the core of the ESRF's success.

Training and development

Our unique and vibrant setting appeals to early-career scientists, engineers and technical staff, allowing them to train and develop their scientific and technical abilities.

This fertile environment drives the transfer of expertise to other research projects, to industry and to society. We dedicate a significant part of our yearly budget to training staff.

Our human resources policy encourages internal mobility and many of our staff members have the opportunity to change jobs during their career.

Graduate schemes

The ESRF supports many initiatives and public events aimed at sharing knowledge of science and engaging with a diverse range of audiences, including high-school students and younger children. The ESRF offers educational programmes for students of all levels.

Each year, the HERCULES European School, the Joint Universities Accelerator School (JUAS), and the International Summer Student Programme organized jointly with the Institut Laue-Langevin, offer introductory lectures and specialized courses, practical sessions, tutorials and visits to other European research facilities.

What we are looking for

We are looking for passionate and curious individuals who are eager to collaborate in an eminently international open environment. We welcome people who want to contribute to a better understanding of the world around us and to inspire and drive progress. We welcome people in many different disciplines (e.g. science, engineering, management, administration) who contribute through their diversity and professional skills to push the frontiers of science.

Profile can be viewed at
physicsworldjobs.com

LOCATION
Grenoble, France

NUMBER OF EMPLOYEES
700+ staff members; several hundred on scientist, graduate and student contracts

MAIN AREAS OF RESEARCH
The ESRF has defined seven EBS Science goals, in line with UNESCO's objectives for sustainable development and with the global challenges identifed by the EU's Horizon Europe research and innovation programme:

- Health innovation, overcoming diseases and pandemics
- Materials for tomorrow's innovative and sustainable industry
- Clean energy transition, sustainable energy storage and clean hydrogen technologies
- Planetary research and geoscience
- Environmental and climatic challenges
- Bio-based economy and food security
- Humanity and world cultural heritage

POSITIONS RECENTLY RECRUITED FOR
Scientists, postdocs, PhD students, engineers, technicians, administration, management

DESIRED DEGREE DISCIPLINES/CLASS
From apprenticeship to PhD, in various disciplines (e.g. science, engineering, management, administration)

HOW TO APPLY
Apply online at **esrf.gestmax.eu/search**. For further information contact **recruitment@esrf.fr**

CLOSING DATE
All year round

CONTACT
European Synchrotron Radiation Facility (ESRF)
71, avenue des Martyrs
Grenoble 38000
France
Tel +33 04 76 88 20 00
www.esrf.fr

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Innovating Today, Imagining Tomorrow

The Hong Kong University of Science and Technology (HKUST) is a dynamic, young, research university with a diverse international student body and faculty who relentlessly pursue excellence in teaching and research. Situated on a hillside overlooking scenic Clear Water Bay at the eastern edge of Hong Kong and the southeastern coast of China, HKUST has rapidly established itself as a leading institution on the academic world map. Since the university's founding in 1991, the physics department has grown from 9 to 38 faculty members and now has over 190 research graduate students. The department's research areas have also expanded to include condensed-matter physics; atomic, molecular, and optical systems and quantum optics; particle physics and cosmology; quantum information; scientific computation; soft-matter and biological physics; and metamaterials.

The physics department promotes the pursuit of cutting-edge research by cultivating a collaborative, supportive, and cohesive environment. For example, the Center for Fundamental Physics focuses on theoretical and experimental research about the origin, fate, and fundamental building blocks of the universe, and it has participated in several global endeavors, including the ATLAS collaboration at CERN. The emphasis of the Center for Metamaterials Research is on the design, fabrication, and characterization of different metamaterials to explore novel wave phenomena and to manipulate light and sound in ways not possible before. The Center for Complex Quantum Systems brings together a team working across several core areas with focuses on quantum materials and devices, quantum control, and software. The newly established Center for Theoretical Condensed Matter Physics strives to foster a dynamic research atmosphere and encourage international academic collaboration in a major subfield of physics.

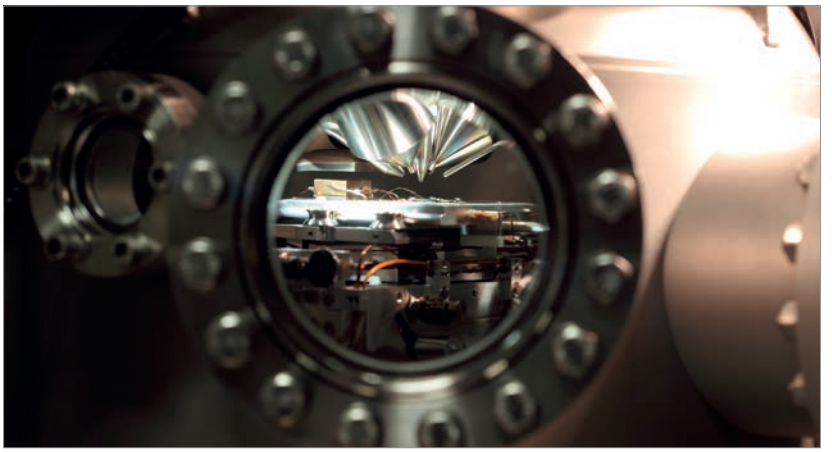
The physics department's research efforts are supported by critical infrastructure, specialized equipment, high-performance computer clusters, and services provided by the university's Central Research Facilities. For example, the Materials Characterization and Preparation Facility offers advanced characterization tools, sample and materials preparation apparatus, and a helium liquefier. The Nanosystem Fabrication Facility has state-of-the-art equipment for developing innovative micro/nano devices and systems.

The department's goals for future growth are to enhance existing core strengths and build up world-class capabilities in rapidly developing areas aligned with university initiatives, such as big data and renewable energy and new energy materials. To achieve these goals, the department will strive to continuously attract outstanding new faculty members at all ranks, and it plans to fill 10 new faculty positions in the next few years.





THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY: DEPARTMENT OF PHYSICS



The Hong Kong University of Science and Technology (HKUST) is a dynamic, young research university with a diverse international student body and faculty. Since the university's founding in 1991, the physics department has grown from nine to 38 faculty members and now has more than 190 research graduate students.

Why work for us

Situated on a hillside overlooking scenic Clear Water Bay at the eastern edge of Hong Kong and the southeastern coast of China, HKUST has rapidly established itself as a leading institution on the academic world map. The HKUST physics faculty members are currently working on a broad range of research areas, from the smallest to the largest scale. Their cutting-edge research is supported by critical infrastructure, specialized equipment, high-performance computer clusters, and services provided by the university's Central Research Facilities.

Training and development

The physics department promotes the pursuit of cutting-edge research by cultivating a collaborative, supportive and cohesive research-intensive environment and the development of talent. The department has an inclusive academic/administrative committee structure that focuses on research strategy and planning; faculty recruitment and mentoring, professional review and advancement; and postgraduate studies and affairs. In addition, the department has implemented a number of mechanisms to promote faculty diversity and to enhance the integration and professional development of junior faculty members.

Graduate schemes

The physics department manages and offers research postgraduate degrees (MPhil and PhD) in physics and in nanoscience and technology with an annual enrolment of 40–50 students. The department also manages a one-year taught Master of Science programme on data-driven modelling with an enrolment of approximately 60 students. Our postgraduate programmes are built upon our long-standing practices for educational enrichment, quality assurance and career development. They prepare students to attain a broad horizon of careers from academic institutions to hi-tech industries.

What we are looking for

The department's goals for future growth are to enhance existing core strengths and build up world-class capabilities in rapidly developing areas aligned with university initiatives, such as data science, new energy materials, and quantum technologies. To achieve these goals, the department will strive to continuously attract outstanding new faculty members at all ranks, and it plans to fill 10 new faculty positions in the next few years.

Profile can be viewed at **physicsworldjobs.com**

LOCATION
Hong Kong

NUMBER OF EMPLOYEES
160

MAIN AREAS OF RESEARCH
Cold atoms, optics and quantum information; condensed-matter experiments and advanced materials; condensed-matter theory, statistical and computational physics; particle physics and cosmology; soft matter and biological physics; metamaterials, photonic and phononic crystals

POSITIONS AVAILABLE
We seek (i) experimental candidates in quantum matter and quantum information, including quantum and low-dimensional materials, materials with strong electronic correlations, cold atoms, quantum optics, and quantum-enabled technologies; (ii) theoretical candidates in condensed-matter theory, statistical physics, neural networks or data analytics; and (iii) experimental and theoretical candidates in high-energy theory and cosmology, particle-physics experiment, and observational cosmology

DESIRED DEGREE DISCIPLINES/CLASS
Must possess a PhD in physics or related field and provide evidence of strong research productivity

HOW TO APPLY
Apply online: **physics.ust.hk/eng/detail.php?otherid=3**

CLOSING DATE
All year round

CONTACT
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The Hong Kong University of Science and Technology
Clear Water Bay, Kowloon
Hong Kong
Tel +852 2358 7500
E-mail physjobs@ust.hk
physics.ust.hk

中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

RECRUITMENT OF OVERSEAS HIGH-LEVEL TALENTS

The Institute of High Energy Physics (IHEP), a Chinese Academy of Sciences research institute, is the largest laboratory for the study of particle physics in China.

Working at IHEP are more than 1500 full-time staff, and more than 1000 postdocs and graduate students. Particle physics is a very collaborative and international field, and we have partnerships and experiment collaborations with dozens of universities and research institutions across China and worldwide.

IHEP is always searching for more excellent scientists and engineers, at all career stages, to join us in exploring this amazing universe. We have long-term and short-term opportunities available in our world-class research programmes, which include the fields of high energy physics, particle astrophysics, computer science, cosmology, synchrotron radiation, and advanced accelerator physics. In particular, IHEP is making strong efforts to internationalize our faculty members from different culture and ethnic backgrounds. We welcome all applicants worldwide.

I. Preferred research directions

• Experimental particle physics, including neutrino physics, e^+e^- collider experiments, and high-energy frontier, as well as R&D of advanced high-energy physics instrumentation • Accelerator science and technology, including innovative theoretical research and cutting-edge technological R&D for particle colliders, advanced light sources, and industrial/medical applications of accelerators • Theoretical particle physics and cosmology • High-energy astrophysics and instrumentation for X-ray/gamma-ray/neutrino astronomy and cosmic rays, and CMB experiments and science • Modern X-ray research at the High Energy Photon Source (HEPS), including Beamline Methodology and Instrumentation, Beamline Engineering, Control/Computing and Data Analysis, AI for X-ray Science • Radiotherapy and nuclear medicine • Applications of synchrotron radiation in Environmental science, Life science, Material science, and Nanoscience • Positron annihilation spectroscopy and its application • Computer Science, including Computing and storage, Scientific software, AI and QC computing • X-ray science and advanced X-ray instrumentation (diffraction, fluorescence, Compton scattering) • Materials and condensed matter science • Neutron scattering science and instrumentation

II. Positions and requirements

Position 1: Full Professors
- Professor or equivalent position from a well-known overseas university or research institute
- Possess broad international influence in one's academic field and grasp key technologies; be able to solve key technological problems; be an academic and technical leader

Position 2: Associate Professors
- Not less than three years of continuous postdoctoral work experience at a well-known overseas university or research institute
- Preferably under 40 years old
- Tenure-Track Associate Professor positions are available

Position 3: Tenure-Track Assistant Professors
- Not less than two years of continuous postdoctoral work experience at a well-known university or research institute
- Preferably under 35 years old

Position 4: Key Technologists
- Research experience from a well-known overseas or domestic university or research institute
- Significant technological achievements.
- Preferably under 40 years old

III. Benefits for all positions

• Sufficient start-up funding • Competitive salary and housing subsidy • Well-furnished apartments to rent • Relocation expenses • All standard benefits: insurance package, etc. • Help to settle down and enroll children into kindergarten and school

IV. How to apply

Please submit your Curriculum Vitae to **lianggj@ihep.ac.cn**.

Inquiries

Mr. Liang, E-mail: **lianggj@ihep.ac.cn**, Tel: (86) 010-8823 8366

english.ihep.cas.cn • english.ihep.cas.cn/csns

INSTITUTE OF HIGH ENERGY PHYSICS – CHINESE ACADEMY OF SCIENCES

The Institute of High Energy Physics (IHEP), a Chinese Academy of Sciences research institute, is China's biggest laboratory for the study of particle physics. We want to understand the universe better at the most fundamental level – from the smallest subatomic particles to the large-scale structure of the cosmos. We also want to use the knowledge and technology that comes from our research for the good of humanity. As well as theoretical and experimental research into particle and astroparticle physics, we have a broad range of research in related fields such as accelerator technologies and nuclear analysis techniques. The institute also provides beam facilities for researchers in other fields of study.

Why work for us

Working at IHEP are more than 1500 full-time staff, as well as more than 1000 postdocs and graduate students. Particle physics is a very collaborative and international field, and we have partnerships and experiment collaborations with dozens of universities and research institutions across China and worldwide.

IHEP is always searching for more excellent scientists and engineers, at all career stages, to join us in exploring this amazing universe. In particular, IHEP is making strong efforts to internationalize our faculty members from different culture and ethnic backgrounds. We welcome all applicants worldwide.

We have doctoral programmes in six scientific fields, as well as engineering doctoral programmes in nuclear technology and computer technology. We also offer five full-time professional Master's degree programmes in engineering. For those at a later stage in their careers, we offer formal postdoctoral training in physics and in nuclear science and technology.

Recruitment objectives

Based on the needs of the research areas and the disciplines development of IHEP, we are now publicly recruiting overseas outstanding talents and scholars of relevant disciplines who possess research abilities and innovation awareness.

What we are looking for

We are always looking for more scientists and engineers, at all career stages, to join us in exploring this amazing universe. Whether you are a student, postdoc or established career scientist, why not consider bringing your skills to IHEP? There are long- and short-term opportunities available in our world-class research programmes, including high-energy physics, particle astrophysics, cosmology, synchrotron radiation and advanced accelerator physics.

Profile can be viewed at **physicsworldjobs.com**

LOCATION
Beijing, China

NUMBER OF EMPLOYEES
1500+

MAIN AREAS OF RESEARCH
Experimental particle and nuclear physics, theoretical physics, astronomy and astrophysics, nuclear technology, multidisciplinary research, accelerators, neutron physics and condensed-matter physics

POSITIONS RECENTLY RECRUITED FOR
Postdoctoral, tenure-track, research, senior research

DESIRED DEGREE DISCIPLINES/CLASS
Minimum 2.1

HOW TO APPLY
Contact **lianggj@ihep.ac.cn**

CLOSING DATE
All year round

CONTACT
Institute of High Energy Physics, CAS
19B Yuquan Road
Shijingshan District
Beijing
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english.ihep.cas.cn

physicsworld

LIVE

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Physics World Live: Careers Coming April 2025

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IOP Publishing is a wholly owned subsidiary of the Institute of Physics, a leading scientific society with a worldwide membership of physicists from all sectors. Complementing the Institute's mission of promoting physics and bringing physicists together for the benefit of all, IOP Publishing provides a range of journals, ebooks, magazines, conference proceedings and websites for the scientific community. Any profits generated by the publishing company are used by the Institute to support science and scientists in both the developed and developing world.

Why work for us

IOP Publishing provides a friendly, positive, open, relaxed but purposeful environment. People who come to work here tend to stay. This is because it feels like you come to work with your friends, not just colleagues. We like to think that we've got the kind of environment that encourages people to do well and to enjoy what they do. We believe in treating each other with respect, providing an opportunity for you to contribute to our future. IOP Publishing is a great place to work.

Our success is made possible by the talent, energy and commitment of our people to the company and what we do. This success is founded on having the right people in the right place, in an environment in which they can flourish.

What we are looking for

As an organization, we are the sum of our parts. While we employ specialists in a range of fields, all our employees share a number of qualities and and attributes: our people are professional and dedicated, talented and energetic. They work collaboratively to help us expand in a rapidly changing scientific landscape. The IOP Publishing culture is one of growth, learning and innovation, and we are looking for people who want to develop, innovate and succeed; people who see the exciting opportunities that digital publishing has to offer.

Join the community

Making science better, together: be part of a community working together to make science better. A society publisher with the perfect blend of not-for-profit purpose and commercial perspective. Here, we help each other be the best we can be – a team big enough to impact and small enough to care.

Profile can be viewed at **physicsworldjobs.com**

LOCATIONS
UK, US, China, India and Japan

NUMBER OF EMPLOYEES
540

POSITIONS RECENTLY RECRUITED FOR
Associate editor, publishing services assistants, research integrity officer, platform engineer, product manager, campaign manager

HOW TO APPLY
For more information about our recruitment process, visit **ioppublishing.org/join-the-community**. For a list of current vacancies, visit **www.ioppublishingcareers.org/current-vacancies.html**

CLOSING DATE
All year round

CONTACT
IOP Publishing
No.2 The Distillery
Glassfields
Avon Street
Bristol BS2 0GR
UK
E-mail careers@ioppublishing.org
ioppublishing.org

IMPRS for Quantum Science and Technology
INTERNATIONAL MAX PLANCK RESEARCH SCHOOL

MCQST

Munich Quantum Valley

Join the Quantum Community in Bavaria

Revolutionize quantum science and technology within a broad, collaborative, and rapidly developing reseach community. Our close network of institutions and research organizations offers educational and research opportunities for scientists from various fields at all career stages.

- **IMPRS-QST** is a joint graduate program uniting the Max Planck Institute of Quantum Optics, Ludwig Maximilian University of Munich, and the Technical University of Munich.

  IMPRS-QST serves as a platform for early-career quantum researchers, fostering collaboration, scientific exchange both in Germany and internationally, and comprehensive transferable skills development. In partnership with MCQST, IMPRS-QST offers several highly competitive doctoral fellowships annually, supporting exceptional young scientists as they pursue their PhDs within leading partner research groups..

  Find more at imprs-quantum.mpg.de!

- **MCQST** is a Cluster of Excellence funded by the German Research Foundation (DFG, Deutsche Forschungsgemeinschaft). More than 500 scientists from various disciplines are working on an ambitious research program that covers all areas of quantum science and technology from basic research to applications.

  MCQST encourages interdisciplinary collaborations and offers support programs on all career levels ranging from bachelor's students up to independent researchers. With a multitude of different events and outreach formats, MCQST is a driving force when it comes to community building.

  Find more at mcqst.de!

- **MQV** is an initiative supported by the Bavarian state government, uniting quantum activities in Bavaria under one umbrella. Its vision is to create an ecosystem for quantum technologies that combines research, technology development, and education in academia with industry.

  MQV focuses on developing competitive quantum computers and aims to fabricate systems with up to 1000 qubits within 5 to 10 years and develop fault-tolerant quantum computers in the long term. MQV provides annual doctoral scholarships to talented physicists, computer scientists, and engineers to do their PhD in quantum-related fields at any Bavarian university.

  Find more at munich-quantum-valley.de!

Shape the future with us in the Bavarian Quantum Community!

We are comprised of several organizations: the International Max Planck Research School for Quantum Science and Technology (IMPRS-QST), the Munich Center for Quantum Science and Technology (MCQST), and the Munich Quantum Valley (MQV). Together, we form a collaborative quantum science and technology hub in Bavaria. In cooperation with multiple research institutions and industry partners, we unite to advance quantum computing, attracting experts in physics, mathematics, computer science and engineering. We also provide a dynamic platform for students and professionals in quantum science.

Why study with us

MQV and MCQST, as well as other partners, offer a comprehensive educational environment for quantum studies. Various universities within the network provide specialized Bachelor and Master courses and programmes, doctoral and postdoc fellowships, and research internships, emphasizing the integration of research, technology development, and education in quantum science and technology. All three programmes offer unique opportunities for collaboration, diversity and career advancement in quantum fields, making Munich a perfect destination for early quantum science studies.

Training and development

In Munich, students and professionals have access to multiple training and development opportunities. IMPRS-QST graduate school focuses on doctoral training across quantum disciplines. MCQST offers support structures on all career levels, summer Bachelor programmes, Master's and doctoral programs, as well as opportunities for postdocs, and equal opportunity programmes. MQV offers a wide choice of research groups and provides annual doctoral fellowships. These programmes collectively offer a comprehensive pathway for those aiming to excel in the quantum science and technology sector.

What we are looking for

We're looking for dedicated researchers with strong analytical and problem-solving skills, particularly in physics, engineering, mathematics, computer science, or related fields. The ability to work in international multidisciplinary teams, a strong fundamental or applied research background, and commitment to scientific excellence are key. If you show passion for discovery in quantum computing, quantum communication, or quantum materials and if you're ready to push the boundaries of quantum science and technology, join us!

Profile can be viewed at
physicsworldjobs.com

LOCATION
Munich, Bayern, Germany

NUMBER OF RESEARCHERS
15+ academic institutions

MAIN AREAS OF RESEARCH
IMPRS-QST: atomic physics and quantum optics, solid-state physics, quantum information theory, and quantum many-body systems.
MCQST: quantum information theory, quantum simulation, quantum computing, quantum communication, quantum metrology and sensing, quantum matter, and explorative research in quantum science.
MQV: quantum computing technologies including superconducting qubits, neutral-atom qubits, trapped-ion qubits, quantum computing theory, and applications

POSITIONS RECENTLY RECRUITED FOR
All institutions within our network regularly recruit a variety of positions across research fields and job levels

DESIRED DEGREE DISCIPLINES/CLASS
From interns to trainees, from students to graduates, from PhD to postdoc, from postdoc to management positions – all in a wide variety of specializations

HOW TO APPLY
Please find information about our campaigns on IMPRS-QST, MCQST, and MQV websites and social media

CLOSING DATE
All year round

CONTACT
Munich Quantum Valley
Leopoldstr. 244
Munich 80807
Germany
Tel +49 89 208039-172
E-mail info@munich-quantum-valley.de
munich-quantum-valley.de

river lane

Are you ready to tackle quantum's biggest challenge?

We're looking for talented people who want to make an impact.

Collaborate with our team of world-leading scientists and engineers to achieve something unprecedented: build an error correction stack that unlocks useful quantum computing.

Today's quantum computers are overwhelmed by system errors, making it impossible to unlock their full potential. To truly realise the transformative power of quantum technology, we need to reduce these errors by 10,000x. At least.

But how? Riverlane is solving this problem by building Deltaflow,® the world's first quantum error correction stack. It's a complex challenge that requires dedicated and diverse talent. This is where you come in.

You don't necessarily need quantum experience—just a curious mind, a love for solving challenging problems and a desire to make a real impact.

At Riverlane, every day presents an exciting new challenge. Our technical teams collaborate to publish world-changing research and file important patents to help us deliver this ground-breaking technology.

Excited by the chance to help build Deltaflow? Your work will push the boundaries of what's possible. Together, we'll shape the future of computing. **Are you ready for the challenge?**

Our teams require a range of talent, from entry level interns and graduates, to highly experienced team members. Typical roles include:

- Quantum Error Correction Researchers
- Software Engineers (including Embedded & System Software)
- Hardware Engineers (FPGA, ASIC, Verification)
- Project & Programme Managers
- Product Management

Apply today!
Check out our current opportunities at www.riverlane.com/jobs

river lane

Riverlane is developing Deltaflow, a quantum error correction (QEC) stack designed to fix the trillions of data errors hindering scalable quantum computing. Backed by top experts in QEC and chip design, Riverlane now supports over half of the world's quantum computing companies, tackling quantum's defining challenge: error correction at scale.

Why work for us

Join us to shape the future of computing. As part of our award-winning team, you'll contribute to our unique, inclusive culture that values diverse perspectives and fosters collaboration. With a generous benefits package, Riverlane empowers you to reach your full potential in a supportive environment of continuous learning, where everyone's ideas and experiences drive innovation. You'll gain exposure to the world's leading quantum computing companies – our partners – pushing the boundaries of every type of quantum computer and redefining what's possible.

Training and development

Riverlane offers a fantastic environment for professional growth. We recognize that everyone learns differently, so we offer a range of learning opportunities to help you develop and achieve your full potential. From on-the-job learning and regular technical talks, to external events and conferences, coaching and much more, we support you to develop your skills in a way that works for you. Our clear career development frameworks ensure you receive regular feedback and have a transparent path to accelerate your career.

Graduate schemes

We offer summer internships for Bachelor's, Master's, and PhD students (10–12 weeks), along with longer PhD internships (3–6 months), providing hands-on experience at the cutting-edge of quantum computing. Our graduate scheme is designed for STEM graduates to develop their quantum engineering skills, with the chance to grow into future leaders in the quantum industry. Join us for an unparalleled opportunity to kickstart your career and make quantum computing useful, sooner.

What we are looking for

At Riverlane, our greatest strength is our people. We seek curious, collaborative individuals who are passionate about advancing error-corrected quantum computing. Prior quantum experience is not always required – if you're eager to learn and love solving complex problems, we want to hear from you! We value collaboration, openness, pioneering spirits, curiosity and a user-focused mindset. Join us to help build the future of quantum computing, where your skills and ideas will make a real impact.

Profile can be viewed at
physicsworldjobs.com

LOCATIONS
Cambridge, UK; Cambridge, Boston, US

NUMBER OF EMPLOYEES
100

MAIN AREAS OF RESEARCH
Quantum error correction, quantum decoding, quantum algorithms, fault tolerant applications

POSITIONS RECENTLY RECRUITED FOR
Quantum error correction researcher; engineering roles, including: system engineer, embedded software, FPGA/ASIC, digital design); graduates; interns

DESIRED DEGREE DISCIPLINES/CLASS
We hire at all levels, and previous qualifications and experience will depend on the role and level of seniority. A background in quantum computing is often not required. Our technical roles typically require a background in computer science, physics or maths. Please see our website for specific job requirements

HOW TO APPLY
View **www.riverlane.com/jobs**

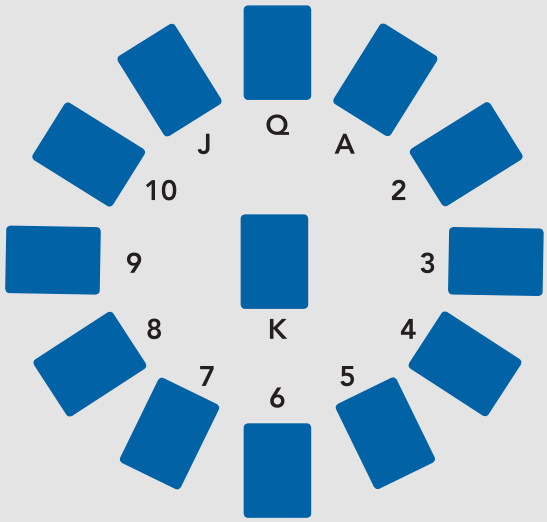
CLOSING DATE
All year round

CONTACT
Riverlane
St Andrew's House
59 St Andrew's Street
Cambridge CB2 3BZ
UK
E-mail team@riverlane.com or jobs@riverlane.com
www.riverlane.com

Can You Solve This?

Clock Solitaire

Consider a standard 52-card deck shuffled uniformly at random. Divide the deck into 13 piles of four cards each, and label the piles "Ace," "2," "3," … "Queen," "King." Note that the label of each pile is independent of its contents.



With this setup, we're ready to play Clock Solitaire. To start, select one of the piles. Pick up the top card and view the card's rank. Discard it to the side, and then draw your next card from the pile according to the rank you just saw.

Steps (2) and (3) are repeated until you either get stuck or win. "Getting stuck" means you attempt to draw from a pile that is already empty, breaking the cycle and leaving you in a dead end. "Winning" refers to drawing all 52 cards and never getting stuck.

What is the probability that you win?

Visit us at the Global Physics Summit Career Fair to talk through your solution.

Learn more about careers in quant

"At Susquehanna, I still get to do all of the things that I loved about grad school."

"Before I joined Susquehanna, I was a PhD student in high energy theoretical physics. To some extent, finance is another approach to understand the world, much like physics in many ways. Both fields involve research that requires understanding underlying mechanisms, identifying relationships between variables, and constructing models to describe and predict their behaviors. As a result, transitioning from academia to the finance industry was quite seamless for me."

- Susquehanna Quant

SUSQUEHANNA

Susquehanna is a global quantitative trading firm founded by a group of friends who share a passion for game theory and probabilistic thinking. Our rigorous and analytical approach to decision making has led us to become one of the largest and most successful proprietary trading firms in the world.

Why work for us

Working at Susquehanna allows you to apply your quantitative skills and systematic thinking to trading environments. To meet the market's unique challenges, our employees are constantly testing their theories in real time. We give you ample space to think deeply about the questions you are contemplating and provide a variety of tools to solve complex problems. Beyond the work, we pride ourselves on fostering a collaborative and meritocratic structure where people are rewarded based on impact.

Training and development

As a quant, you will begin your career in the Quantitative Research + Systematic Trading Program, which bridges the gap between academia and industry. You will gain insights into financial markets to ensure a well-rounded understanding of the industry. We teach you how to gather, analyse, and interpret financial data using internal data sets. This foundation prepares you to develop practical strategies for real-world application. Our trading floor serves as an unlimited source of discussion for learning and development.

Graduate schemes

We're looking for PhD and Research Master's students to join our 2025 graduate programmes. Our education programme offers a unique insight into the world of quantitative trading by applying research in probability, statistics, stochastic optimisation, numerical analysis, and machine learning into solving real-world problems. The below opportunities are now open for applications:

- 2025 Quantitative Research Graduate Programme
- 2025 Quantitative Systematic Trader Graduate Programme
- 2025 Quantitative Research 10-week Summer Internship Programme
- 2025 Quantitative Systematic 10-week Summer Internship Programme

What we are looking for

Susquehanna hires STEM PhDs and Master's students who are interested in applying their research, analysis, and development skills to the financial markets. Quantitative researchers develop the building blocks of trading strategies, requiring exceptional attention to detail and a relentless drive for deeper understanding. Quantitative systematic traders enhance and integrate the building blocks that our researchers develop to monetise strategies and manage risk. Both roles require skill in mathematics, statistics, and programming to aid in solving complex problems in our trading environment.

Profile can be viewed at
physicsworldjobs.com

LOCATIONS
Dublin, London, Philadelphia, New York, Sydney

POSITIONS RECENTLY RECRUITED FOR
Quantitative researcher, quantitative systematic trader, quantitative trader

HOW TO APPLY
View our open roles at
bit.ly/susquehanna_pw

CLOSING DATE
All year round

CONTACT
Susquehanna International Group Ltd
International Centre
Memorial Road, IFSC
Dublin 1
D01 T6T0
Ireland
Tel +353 1 802 8000
sig.com

New materials driving the quantum revolution

Andy Doherty/Institute of Physics

New face of quantum Having recently established her own research group, physicist Hannah Stern is ready to get to work developing new materials for quantum technologies.

New materials are often the driving force behind technological breakthroughs. **Hannah Stern** tells Katherine Skipper why she's developing new platforms for encoding, transmitting and manipulating quantum information

Every year one early-career researcher who's made "exceptional contributions to experimental physics" is awarded the Henry Moseley medal and prize from the Institute of Physics (IOP). In 2023 the medal was given to Hannah Stern for her work on understanding the photophysics of semiconductors and 2D materials. As of September, Stern is an associate professor at the University of Oxford, UK. She was previously a research fellow at the University of Cambridge, where she also obtained her PhD in 2017, before a short spell at the University of Manchester.

Stern's group is developing new platforms for quantum technologies, with a focus on materials with quantum states that can be controlled with light. She recently led research with colleagues in the UK and Australia which showed that lattice point defects in hexagonal boron nitride (hBN) have promising properties for quantum technologies, including sensing and optical networking (*Nature Materials* doi.org/10.1038/s41563-024-01887-z).

Katherine Skipper caught up with Stern to discover what motivates her research, what the big challenges facing the quantum sector are, and what the ethos of her new group will be.

What first sparked your interest in quantum technology?

I've always been intrigued by quantum mechanics. When I was an undergraduate at Otago University in New Zealand, I majored in physical chemistry, and I gained experience with spectroscopic techniques. In these

experiments, we would shine light at materials and use the data we collected to understand the electronic structure of those materials on the atomic and molecular level. I found this exciting because it felt like I could really see quantum mechanics at work.

I continued with different forms of spectroscopy for my PhD and learnt a lot more about electronic spin states in materials that could be generated via light. I didn't start thinking about the implications of these systems for quantum technologies until later. As a postdoc, I became interested in states in materials that emit single photons at a time. That was when I realized that the physics I had been studying had applications within quantum technology.

Your research is on light–matter interfaces for quantum technologies. Why is the interaction between light and matter important for quantum applications?

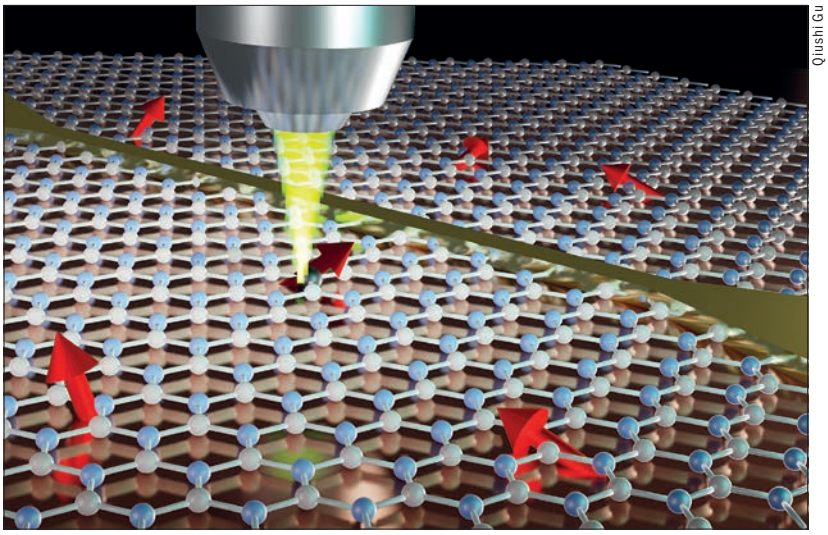
Understanding the interaction between light and matter has always been central to building our understanding of quantum mechanics. Today, light–matter interactions on the single particle level are one of the most useful ways to control and use quantum phenomena for new technologies.

In the first instance, quantum technologies need qubits, which are the quantum equivalent of the classical bit. In simple terms, a qubit is a two-level system that can exist in a quantum superposition state. Qubits can be formed not only from electronic and magnetic transitions within materials but also from single photons. Both form of qubits are being actively developed for different applications.

For example, photons are useful for applications that require transportation of quantum states (i.e. for communication technologies) because they can be sent long distances without losing quantum information, which may be encoded in the photon polarization, for example. Qubits in matter, however, such as electronic or nuclear spins, are often better at storing information for longer periods of time. Typically, they can also be controlled more easily than photons so they are more suitable for performing logical operations on the device level, for example in computing or simulation.

What this means is that while light and matter qubits can be used separately for quantum technologies, we can get new functionality by harnessing the interaction between them. A good example is "quantum optical networks". Long-distance optical quantum networks don't exist yet, but it could enable a quantum version of the internet, in which quantum information is distributed across a series of globally positioned nodes.

These nodes could be material qubits, which would send and receive quantum information from photons and store it locally as a quantum memory. As it turns out, a promising material system for this is atomic-scale point defects in materials, which is what I work on.



Qiushi Gu

Handy tool Defects in the lattice structure of hexagonal boron nitride can be detected with photoluminescence, which is handy as such defects can be used under ambient conditions for applications in quantum technology.

What kind of qubits in matter do you study? And how does the interaction with light enable these systems?

Qubits in matter often come in the form of electronic or nuclear spin transitions of atoms or molecules – what are called "spin qubits". Spin is one of the non-intuitive concepts of quantum mechanics that doesn't have a classical analogue – it refers to an intrinsic property (angular momentum) of a particle. Importantly, spin is quantized, meaning particles can only exist in a limited number of possible spin states.

The simplest example is the spin state of a single electron, which can be spin up, spin down or a superposition of those two states. Often the spin state of an atom, defect or molecule is slightly more complex – in fact, the materials I work with are an example of this. But it's typically still possible to think about the spin state in this way.

What's interesting about the spin qubits I work with is that the state of the qubit can be controlled with light. We first use a laser pulse to place the qubit into a useful spin state before manipulating it with a second electromagnetic pulse and using a second laser pulse to "read-out" the new state. Known as optically detected magnetic resonance, it forms the basis of how we use the spin qubit to store quantum information or sense the environment.

The systems I work with are formed from atomic-scale point defects in an extended solid, in this case a 2D material. You could think of these defects as a missing atom in the lattice. The disruption of the lattice creates a "trapped molecule" in the crystal, which is electronically isolated and has well defined electronic transitions between optical and spin states, forming a qubit.

One appealing feature of defects in solids for quantum applications is that they work at ambient conditions, without needing low temperatures or high magnetic fields. The spin control pulse in our experiments is generally in the microwave or radio range, which is good because we can easily implement microwave or radio frequency control on a chip, and at room temperature. It's quite hard to find other isolated quantum objects that can be manipulated at ambient conditions.

What are the applications of spin qubits?

In addition to optical networking applications, one important application is in sensing. Most sensors measure a physical quantity over a bulk, or spatially averaged, sample. An exciting feature of sensors based on single electronic spins is that the sensor itself is now atomic scale and can measure physical quantities with very high (near atomic-scale) spatial resolution.

One particularly active area of quantum sensing right now is quantum nanoscale magnetometry, which exploits the fact that an external magnetic field will shift the energy

of the electronic spin states of a spin qubit.

By measuring the energy shift of the spin states (via optically detected magnetic resonance), we can work out the magnitude and direction of the field at a precise point in space. So by scanning the qubit over a sample, the nanoscale magnetism of materials can be visualized in a way that has not been possible before.

What kinds of materials have spin properties that can be used in quantum technologies?

Several factors determine if a material will be useful for quantum technologies, and they also depend on the technology you are talking about. Typically, if a material that hosts spin qubits is going to be useful for a quantum application, it needs to have a significant spin coherence time, which is how long a spin can hold on to quantum information.

For sensing, generally the longer the coherence time the more sensitive the sensor. For optical networking, the spin coherence time limits how far the photon can be sent in the network. For both applications, typically a coherence time of at least milliseconds is desirable.

The coherence time of a spin qubit can be limited by a range of environmental factors. For solid-state spin qubits based on defects, the most common limitation is magnetic noise from neighbouring nuclear spins and electronic impurities. This means that the spin needs to be isolated, so we typically use materials with a low abundance of spin-active nuclei. Diamond is well known for this.

You've recently investigated the spin properties of defects in hBN: what makes it attractive for quantum applications?

Hexagonal boron nitride is a 2D material with a wide band gap. Because it's an insulator, we wouldn't expect it to interact with visible wavelengths of light, but in about 2016 localized emission of visible light was observed in a hBN lattice (*Nature Nanotechnology* **11** 37).

The idea was put forward that this emission comes from atomic-scale defects in the lattice. By the time I got interested, quite a lot of work had been done to optically characterize the defects, but we didn't know whether this optical transition could interact with an electronic spin state of the defect.

At that point, there was the nitrogen-vacancy centre in diamond and a couple of other defects in silicon carbide, but not many other defects in materials that offered optically addressable electronic spin qubits.

In our most recent paper, we've shown that there are spin states of these defects that we can initialize, control and then read out using light. And these defects can store quantum information for microseconds at room temperature.

To achieve scalability, we need to interface different materials with each other and interface quantum systems with classical electronics and optical components

In addition, many spin qubits require a magnetic field to operate, either to initialize the qubit or to separate the spin qubit transitions from other electronic transitions. Here however, we can control the spin without any magnetic field. While the coherence times are still relatively short compared to other systems, this is all being performed under ambient conditions and in a brand new material platform.

This is also the first time that spin defects with these properties have been studied in a layered material as opposed to a bulk crystal. 2D materials offer natural advantages for fabrication because they can be easily moved from surface to surface and incorporated with other materials and optical components – such as wave guides or cavities – that we may like to use in future to improve the collection of light from the defects. It can be extremely challenging to couple photons that are coming from the middle of a crystal to such components.

All of these things are quite exciting because they speak to this type of physics being available in a device that might operate in real world conditions.

What further work is needed to take hBN out of the lab and into real-world devices?

We have a lot to do. We're interested in technologies that use both the spins and the photons of the hBN defects, and while we've made some strides in understanding the spin physics, we've got a lot more to understand on the optical properties. A big challenge before us is identifying the chemical structure of the defect. We believe it's related to carbon inserted in the lattice but we don't know the exact arrangement of the carbon atoms in the hBN lattice and that's what we're working hard to determine in collaboration with theorists.

The next thing will also be to control the growth of the hBN better and we're working with collaborators on that. We want to create a defect exactly where we want it in the 2D material. This is a massive challenge but we're hopeful that the 2D material will enable this.

Further work will also involve working with companies who are interested in this space, eventually moving towards implementing this material in a full device.

The quantum sector has been growing rapidly but what are the biggest challenges in commercializing the technology?

We are at a point now as a community where a lot has been demonstrated in laboratories and many of the existing challenges are about scaling. For quantum computation with solid-state spins, this means scaling to more and more qubits, while for optical networking, it's about scaling to more and more nodes.

There are also challenges related to materials development. To achieve scalability, we need to interface different materials with each other and interface quantum systems with classical electronics and optical components. One part of achieving this that I'm particularly interested in is identifying new quantum systems in new materials that offer advantages or alternative possibilities alongside the existing ones.

We're seeing that this is an exciting new direction in the field – to look at other material systems and explore these to build a broader material toolkit.

You've recently set up your own research group. What do you want its ethos to be?

The group is both multidisciplinary and interdisciplinary and I think that's important. We cover physics, chemistry, materials science and electronic engineering. Having a number of different views in the room and scientific backgrounds encourages creativity, and it also contributes to scientific risk-taking. In some respects, the work on defects in hBN was risk-taking at the beginning because we didn't know what we would find.

I'm also hoping to build a group where anyone from any background, nationality or minority is welcome. I think it's important the group be broadly inclusive and representative of society. I'll work hard to make sure it stays that way."

Katherine Skipper is a features and careers editor of *Physics World*

Across the quantum landscape

From building hybrid architectures to tackling complex fundamental questions, quantum physicist **Mauro Paternostro** outlines the vast potential on offer from the quantum technology landscape

Queen's University Belfast

Quantum vision Mauro Paternostro outlines the vast potential on offer from the quantum marketplace.

We are in the midst of a quantum renaissance, with researchers in academia and industry all vying to "win" the quantum computing race. The quantum marketplace is booming, with scores of companies, large and small alike, investing in this technology, backed by huge government funding across the globe.

Mauro Paternostro, a quantum physicist at the University of Palermo, Italy and Queen's University Belfast in Northern Ireland, is an expert in quantum information processing and quantum technology. Working on the foundations of the subject, his team is doing pioneering research in cavity optomechanics, quantum communication and beyond. He is also editor-in-chief of the IOP Publishing journal *Quantum Science and Technology*.

In this wide-ranging interview, Paternostro talks to Tushna Commissariat about his views on the quantum landscape – from the "four pillars" of quantum technology and hybrid architectures to the promising marriage between quantum tech and artificial intelligence (AI). Paternostro also underlines the need for continued government funding to realize the true potential of this world-changing technology.

We've seen the quantum bubble blow up over the last decade, but what are the potential advantages and risks of the exponential expansion in quantum technology companies and funding around the world?

Overall, the picture is very positive. Quantum information processing needed a boost from industry, as firms can push for the more pragmatic developments that the field needs. The perspective that industry offers is helping to shape quantum technologies in a more focused manner, when it comes to overall goals. The budding, exploding market – be it in industry or academia – is great.

But, as you point out, there has been a swift growth. And while that is mostly a good thing, there is also a little bit of worry that we might be creating create a big bubble that will burst sooner rather than later. So I think it's a matter of control – we do need to somewhat restrain ourselves, while allowing the research area to grow organically.

I am slightly concerned with the number of small companies that all seem to be developing their own quantum software. Their products have very little to do with true quantum algorithms and are typically classical optimization solutions – which have their own merits. But they are not necessarily what I would call a quantum framework.

On the other hand, some spin-off companies are more oriented towards the implementation of quantum processing platforms, such as quantum sensors. These are really interesting, as it's not just quantum computation at play, but also other physical laws.

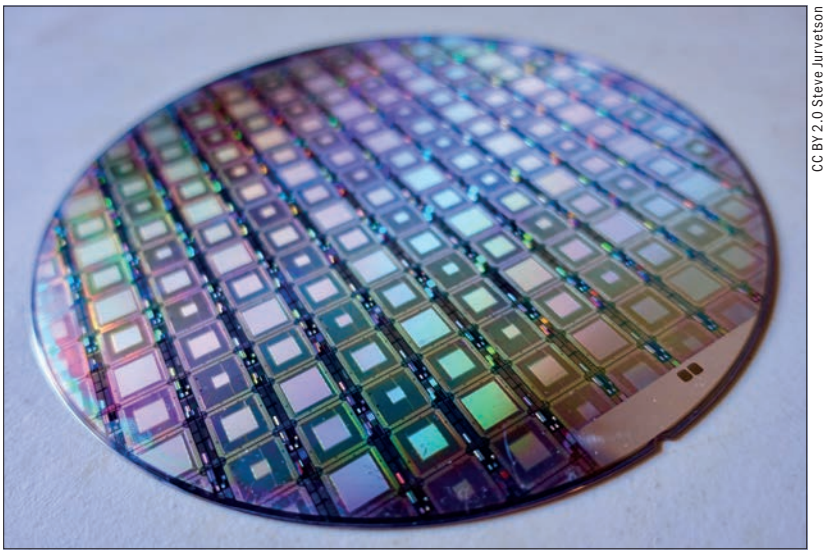
There are four pillars underpinning the developments of quantum technology: quantum computing; quantum simulation; quantum communication; and quantum sensing and metrology. And I would say that

all four are developing in a very healthy way.

Quantum sensing seems to be one of the most advanced, together with communication thanks to the maturity of the technologies they can leverage. While the involvement of industry is beneficial and promising, we should be wary of the wild speculation and "inflation" that comes from trying to jump onto a fast bus, without having the full fare for the ride at hand.

And while I am often sceptical of smaller companies, you also sometimes get concerning news from the big players. For example, Chinese tech firm Alibaba had an interest in developing quantum computing platforms and solutions, until it suddenly decided to close its in-house quantum team at the end of last year, stating it would rather focus on being a leader in AI research.

Was this simply a business decision, or is Alibaba smelling something that we have not yet smelled? I guess we will have to wait and see. Overall, I think the future is bright and the involvement of industry is very good news.



Tech triumph A wafer full of quantum processors from D-Wave, a Canadian quantum-computing company.

There are a number of different quantum-computing technologies vying for top spot – from trapped ions and quantum dots to superconducting and photonic qubits. Which do you think is most likely to succeed?

I'm sort of an agnostic, in that I don't believe that the first quantum device we build will be fully quantum. I know for some this is a controversial take, but it's an opinion shared by many others in my field. What I think we will end up with is a hybrid architecture, where the best of high-performance computing (HPC) will interface with quantum-computing architectures.

Maybe these noisy intermediate-scale quantum (NISQ) architectures will be joined by a full-fledged HPC architecture that will boost their performance, or vice versa. The quantum resources put on the table by this sort of hybrid device will enhance the performance that current classical HPC can produce. I strongly believe in the feasibility of that sort of hybrid architecture – a fully quantum solution is still a long way from where we are now.

Also, I'm not entirely convinced that we will have the ability to manage the massive resources that would be needed to make full use of the gap in computational power that a quantum computer would offer. A medium-term goal aiming for this hybrid HPC quantum architecture will be a much more realistic – and potentially very fruitful architecture – to pursue. I'm mildly optimistic that something will come up in my lifetime.

You mentioned that quantum sensors are already being developed for a wide variety of applications including healthcare, construction and even gravity measurement. What's new and exciting in that area?

Quantum sensors are developing amazing capabilities to investigate mechanisms that so far have been elusive. Essentially, these sensors help us to better detect the potential quantum effects of forces like gravity, which many researchers in the UK have an interest in pursuing. A substantial fraction of the experimental community is pursuing these goals – with the University of Birmingham's quantum hub leading on this front.

I don't think that anyone claims that there is a winning experimental platform to pursue – both cold atoms and optomechanics are some of the most promising ones in that respect. But the theoretical and experimental progress that this area has achieved is very interesting.

Sensors that can probe the fundamental nature of elusive physical mechanisms will, I believe, be a key development. And then there are other sensing devices, such as accelerometers or imagers that are already pretty well established. The UK's National Quantum Technologies Programme has already made significant advances in that regard, and the technology is available and mature enough to have a real impact.

I think industries should heavily invest in this area because, alongside communication, sensing is at the forefront of the implementations of quantum technologies at this stage.

And what about quantum communication?

Quantum communication is probably the most concrete example where academic progress has been put to work, to the benefit of industry-led targets. It's been an absolutely superb example of what we can achieve when these two components work together.

While the progress has been fantastic, there are also controversial aspects, especially when we consider the larger geopolitical implications of a global quantum network. The issue of communication and data security will become significant, so we must carefully consider the wider implications of these technological developments. Geopolitical boundaries are continually changing, and their aims are not always concurrent with scientific goals.

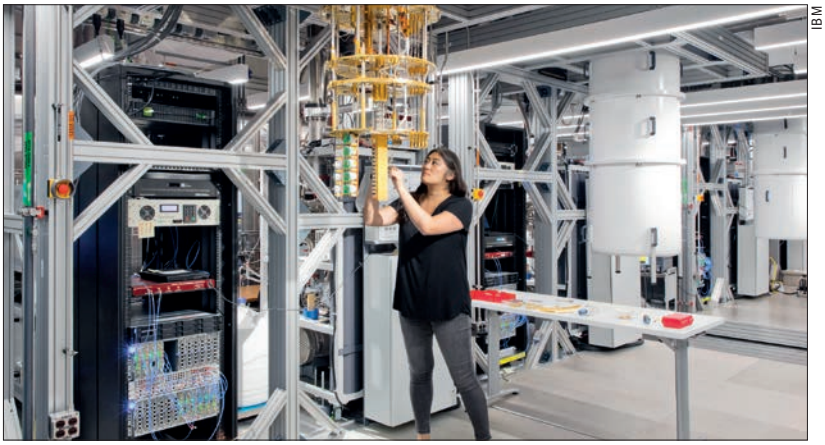
What are some key areas where AI and quantum technologies intersect? Where do they best help one another, and what are potential issues?

This is a very important question. Needless to say, the holy grail for both areas is very close – both AI and quantum computation are based on the development of new algorithms. One hears people talking about quantum machine learning (ML), or quantum AI, but that's not what they really mean. They are not referring to specifically designed quantum algorithms for AI or ML problems. What they mean is the hybridization of classical machine learning or classical AI with quantum problems.

These solutions will depend on the field and the problem we are trying to tackle. But

AUDIO Hartmut Neven, from Google Quantum AI, speaks about Google's new Willow quantum processor and explains how his team created logical qubits with error rates that dropped exponentially with the number of physical qubits used.

Different countries have developed their own area of expertise, in an organic manner. And by doing so, we are all winning as a community – we are all benefiting from all the progress that has been made


IBM

Quantum expertise A research scientist with IBM Quantum in the lab with a large quantum system built by the firm.

in general we are looking at classical techniques for processing data sets; optimizing problems; solving cost functions; and controlling, optimizing and manipulating quantum problems.

It's very promising, as you're putting together the best of the two worlds. From a theoretical point of view, the aim is to tackle questions at the general quantum-mechanical level that need to be addressed, and perhaps the larger and more complicated problems in terms of scale. We want to build tools at the algorithmic level that allow you to cope with the complexity of those problems in a certifiable and consolidated manner.

And the interesting thing is that experiments have started catching up with the theoretical developments. We already have a number of solutions, approaches and methodologies that have been developed in this hybrid scenario where ML and quantum information processing come together.

I hope these experiments are fully investigated in the next few years, and don't get caught up if the AI and quantum bubble does burst. I doubt that would be the case though, because AI is here to stay, while ML is now an unmissable tool used by data analysts worldwide. If we have any ambition to scale up the complexity of the problems that we can and should tackle, then we must focus on developing these tools.

What new initiatives are going on in this area?

Earlier this year, UK Research and Innovation (UKRI) announced that it is funding nine new research hubs to "deliver revolutionary AI technologies" to tackle complex problems from healthcare to energy as well as 10 other studies to define "responsible AI". I know that a number of these have a quantum component – especially in healthcare, where AI-based solutions are absolutely fundamental, but there may be quantum solutions as well.

So I'm very optimistic when it comes to the merger of AI and quantum tech, as long as the development of an AI framework is regulated. Right now, the European Commission is formulating the legal framework for its AI Act, which will address the risks that AI might pose, and the global role the EU hopes to play in regulating the technology. Both the UK and the US have been working on similar frameworks for a while already, so we should have some global policy and regulation formulated, sooner rather than later.

As long as this development follows a regulated policy with solid framework, AI's interactions with quantum technologies should create a useful two-way feedback mechanism that will help both fields grow significantly.

When it comes to quantum-technology funding by governments across the global stage, what specific areas would you like to see further investment in?

My grants! But on a more serious note, government-level investment has been widespread and substantial for what is essentially still an emerging scientific field. Compared with some other areas that receive science funding, such as military or medical research, the amount of money that has been put on the plate is almost ridiculous – but it's a very good thing for us of course. A benefit of this kind of government spending is that it forces us to form a community and come up with shared goals.

If we refer to the aforementioned four pillars, there is an underlying connection of fundamental physics and theoretical developments. Different countries have chosen one or more pillars to focus on, depending on their expertise and resources. The US is very focused on computation. The EU is more widespread and so the situation is more complex, but there is major investment in communications, as well as a growing interest in simulation, while a number of EU national strategies are also focused on sensing.

The UK is also trying to cover the whole spectrum, but identifying some very well-defined topics, from imaging to computation, and from communication to sensing. There are countries like Finland that have a more experimental approach and are focused on superconducting architectures, as they already have huge facilities available. Singapore, on the other hand, is developing a very strong line of research in satellite-based quantum communication. For a small country, it has huge potential, in terms of both talent and resource.

So different countries have developed their own area of expertise, in an organic manner. And by doing so, we are all winning as a community – we are all benefiting from all the progress that has been made. Some baby steps, some more incremental steps, some huge quantum leaps.

I think it will be really important that governments, national and super national, realize that investment in quantum technologies should be sustained. It's an area that needs continuous, unbroken support to deliver its lofty goals. And we, as the scientific community, must project a coherent picture with the very same set of goals, despite any differences we have. Only then will we be best placed to translate quantum technologies to life-changing realities.

Tushna Commissariat is a features and careers editor of *Physics World*

Going the distance

Prineha Narang, a physicist at UCLA who works at the intersection of condensed matter and quantum physics, tells Rob Lea about the challenges of defining yourself as a researcher, why she still puts fun at the forefront of her work, and what scientists can learn from distance running

Prineha Narang

Staying power Prineha Narang says it's important that her team feel excited about their work, and that lessons learned from running have helped her persist through challenges in her research.

When she was in middle school in the US between the ages of 11 and 14, Prineha Narang wasn't planning on becoming a physicist. As a sporty preteen, her attention was instead on the running track. "I was convinced that I was going to do something athletic. I had always been good in my math and science courses, but I'd never really thought of that as a career," Narang explains. "It was actually a track coach who gently pushed me towards STEM (science, technology, engineering and mathematics) saying, 'You're good at running, but I hear you're really good at math and science.'"

The coach's comment would seem to be justified. Narang went on to do a PhD in Applied Physics at Caltech, and after postdoctoral positions at Harvard University and the Department of Physics at MIT, she joined the faculty at Harvard in 2017. But she says there wasn't a single defining moment where she realized she was destined for a career in physics, describing her trajectory as a gradual progression.

Now Narang runs a group at the University of California Los Angeles (UCLA) where she researches non-equilibrium materials science – controlling quantum matter and quantum systems using external drives like lasers or electron beams. The work of the NarangLab spans areas of physics, chemistry, computing and engineering.

Writing your own rules

Narang says that her journey to define herself and her research has not been seamless. She notes that there was a lack of programmes focused on undergraduate women in physics, and little support for women in the field, adding that perhaps this inequality was something that hadn't been identified as a problem at that time.

"One of the challenges was finding someone who could help me find my way through all of the different things you could do in this field, as I recognized that there weren't that many female faculty members to assure me that I belonged there," Narang says. "That kind of a question remarkably went away when I became a graduate student at Caltech and had incredibly supportive mentors, both in my own research as well as others on the faculty."

Another challenge Narang faced came after she had become a full faculty member. She had to decide what her research area would be and how it would fit in the broader sphere of physics. The work of the NarangLab is hard to fit into a box, but that's exactly how she likes it. "In our group, we have embraced this interdisciplinary approach," Narang explains. "We think about how you can bring together condensed matter and optics, how you can bring together device physics – and make this happen in a synergistic manner."

I get a lot of satisfaction out of communicating the science that we're doing because I'm excited about it

Staying curious

Narang's research has received many awards, including the 2023 Maria Goeppert Mayer Award from the American Physical Society and a 2023 Guggenheim Fellowship in Physics. She was also recently selected as a United States Science Envoy. But she says there's a surprising secret to her work. "The focus of the group is doing excellent science while having fun," she explains. "That's something that we emphasize a lot, and it comes from my own experience in science. I want people to feel that excitement when working on a topic, especially when they have a new result."

Narang applies the same enthusiasm when communicating their results. She adds that this is particularly important when disseminating ideas that aren't easily accessible, such as those that the team works with every day. "I think it's really important to go out there and make that effort," Narang says. "I get a lot of satisfaction out of communicating the science that we're doing because I'm excited about it, and I feel like if I could get other people to see it the way I do, they would be excited about it, too."

Life lessons

Narang doesn't let doing and talking about exciting physics stop her from outdoor pursuits like mountain climbing and running – and though this may just be a hobby today, her early interest in athletics has resulted in life experience that she carries over to her career.

"I still run. Science has a lot in common with distance running. For example, the most important thing is actually to get out there and run and continue to try," Narang says. "Some days are amazing, and other days you feel like, 'Oh my gosh, that crushed me'. It kind of feels the same with the science."

Narang adds that the key to overcoming this feeling in both long-distance running and in science is the determination to push through feelings of despondency. "Something I try to convey to junior scientists is that not everything needs to come to you instantly," Narang concludes. "It can be a long road, and that's okay."

Rob Lea is a science writer based in Liverpool, UK, X @sciencef1rst

Wearable quantum technology

Electrical impulses allow us to think, feel and form memories. Mapping these signals in the brain can be used to study cognitive development and disease. **Margot Taylor** and **David Woolger** talk to Hamish Johnston about using quantum-sensing technology to build a wearable system for imaging brain activity

University of Nottingham School of Physics and Astronomy/Simon Litherland

Use your head A quantum-based magnetic sensor has been used to build a wearable brain scanner. By sensing the tiny magnetic field generated by electrical impulses from neurons, Cerca Magnetics' OPM-MEG technology can map the function of the brain. This helmet-based sensor is less bulky and more mobile than alternative imaging methods.

Though she isn't a physicist or an engineer, Margot Taylor has spent much of her career studying electrical circuits. As the director of functional neuroimaging at the Hospital for Sick Children in Toronto, Canada, Taylor has dedicated her research to the most complex electrochemical device on the planet – the human brain.

Taylor uses various brain imaging techniques including MRI to understand cognitive development in children. One of her current projects uses a novel quantum sensing technology to map electrical brain activity. Magnetoencephalography with optically pumped magnetometry (OPM-MEG) is a wearable technology that uses quantum spins to localize electrical impulses coming from different regions of the brain.

Physics World's Hamish Johnston caught up with Taylor to discover why OPM-MEG could be a breakthrough for studying children, and how she's using it to understand the differences between autistic and non-autistic people.

The OPM-MEG helmets Taylor uses in this research were developed by Cerca Magnetics, a company founded in 2020 as a spin-out from the University of Nottingham's Sir Peter Mansfield Imaging Centre in the UK. Johnston also spoke to Cerca's chief executive David Woolger, who explained how the technology works and what other applications they are developing.

Margot Taylor: understanding the brain

What is magnetoencephalography, and how is it used in medicine?

Magnetoencephalography (MEG) is the most sensitive non-invasive means we have of assessing brain function. Specifically, the technique gives us information about electrical activity in the brain. It doesn't give us any information about the structure of the brain, but the disorders that I'm interested in are disorders of brain function, rather than disorders of brain structure. There are some other techniques, but MEG gives us amazing temporal and spatial resolution, which makes it very valuable.

So you're measuring electrical signals. Does that mean that the brain is essentially an electrical device?

Indeed, they are hugely complex, electrical devices. Technically it's electrochemical, but we are measuring the electrical signals that are the product of the electrochemical reactions in the brain.

When you perform MEG, how do you know where that signal's coming from?

We usually get a structural MRI as well, and then we have very good source localization approaches so that we can tell exactly where in the brain different signals are coming from. We can also get information about how the signals are connecting with each other, the interactions among different brain regions, and the timing of those interactions.

Why does quantum MEG make it easier to do brain scans on children?

It's a wearable system, where the sensors are placed in a helmet. This means there is allowed movement because the helmet moves with the child. We're able to record brain signals in very young children because they can move or sit on their parents' laps, they don't have to be lying perfectly still.

We are looking at early brain function in autistic and non-autistic children. If a child could be diagnosed with autism earlier, then interventions could start earlier

Hospital for Sick Children

Testing times Margot Taylor (right) and her postdoctoral fellow Julie Sato (left) place a quantum MEG helmet on a research participant (postdoc Kristina Safar).

Conventional MEG uses cryogenic technology and is typically one size fits all. It's designed for an adult male head and if you put in a small child, their head is a long way from the sensors. With OPM, however, the helmet can be adapted for different sized heads. We have little tiny helmets up to bigger helmets. This is a game changer in terms of recording signals in little children.

Can you tell us more about the study you're leading at the Hospital for Sick Children in Toronto using a quantum MEG system from the UK's Cerca Magnetics?

We are looking at early brain function in autistic and non-autistic children. Autism is usually diagnosed by about three years of age, although sometimes it's not diagnosed until they're older. But if a child could be diagnosed with autism earlier, then interventions could start earlier. And so we're looking at autistic and non-autistic children as well as children that have a high likelihood of being autistic to see if we can get brain signals that will predict whether they will go on to get a diagnosis or not.

How do the responses you measure using quantum MEG differ between autistic and non-autistic people, or those with a high likelihood of developing autism?

We don't have that data yet because we're looking at the children who have a high likelihood of being autistic, so we have to wait until they grow up and for another year or so to see if they get a diagnosis. For the children who do have a diagnosis of autism already, it seems like the responses are atypical, but we haven't fully analysed that data. We think that there is a signal there that we'll be able to report in the foreseeable future, but we have only tested 32 autistic children so far, and we'd like to get more data before we publish.

Do you have any preliminary results or published papers based on this data yet?

We're still analysing data. We're seeing beautiful, age-related changes in our cohort of non-autistic children. Because nobody has been able to do these studies before, we have to establish the foundational datasets with non-autistic children before we can compare it to autistic children or children who have a high likelihood of being autistic. And those will be published very shortly.

Are you using the quantum MEG system for anything else at the moment?

With the OPM system, we're also setting up studies looking at children with epilepsy. We want to compare the OPM technology with the cryogenic MEG and other imaging technologies and we're working with our colleagues to do that. We're also looking at children who have a known genetic disorder to see if they have brain signals that predict whether they will also go on to experience a neurodevelopmental disorder. We're also looking at children who are born to mothers with HIV to see if we can get an indication of what is happening in their brains that may affect their later development.

David Woolger: expanding applications

Can you give us a brief description of Cerca Magnetics' technology and how it works?

When a neuron fires, you get an electrical current and a corresponding magnetic field. Our technology uses OPMs, which are very sensitive to magnetic fields. Effectively, we're sensing magnetic fields 500 million times lower than the Earth's magnetic field.

To enable us to do that, as well as the quantum sensors, we need to shield against the Earth's magnetic field, so we do this in a shielded environment with both active and passive shielding. We are then able to measure the magnetic fields from the brain, which we can use to understand functionally what's going on in that area.

Are there any other applications for this technology beyond your work with Margot Taylor?

There's a vast number of applications within the field of brain health. For example, we're working with a team in Oxford at the moment, looking at dementia. So that's at the other end of the life cycle, studying ways to identify the disease much earlier. If you can do that you can potentially start treatment with drugs or other interventions earlier.

Outside brain health, there are a number of groups who are using this quantum technology in other areas of medical science. One group in Arkansas is looking at foetal imaging during pregnancy, using it to see much more clearly than has previously been possible.

There's another group in London looking at spinal imaging using OPM. Concussion is another potential application of these sensors, for sports or military injuries. There's a vast range of medical-imaging applications that can be done with these sensors.

Have you looked at non-medical applications?

Cerca is very much a medical-imaging company, but I am aware of other applications of the technology. For example, applications with car batteries have potential to be a big market. When they make car batteries, there's a lot of electrochemistry that goes into the cells. If you can image those processes during production, you can effectively optimize that production cycle, and therefore reduce the costs of the batteries. This has a real potential benefit for use in electric cars.

What's next for Cerca Magnetics' technology?

We are in a good position in that we've been able to deliver our initial systems to the research market and actually earn revenue. We have made a profit every year since we started trading. We have then reinvested that profit back into further development. For example, we are looking at scanning two people at once, looking at other techniques that will continue to develop the product, and most importantly, working on medical device approval.

At the moment, our system is only sold to research institutes, but we believe that if the product were available in every hospital and every doctor's surgery, it could have an incredible societal impact across the human lifespan."

Hamish Johnston is an online editor of *Physics World*

The power of diversity

Keith Burnett, the current president of the Institute of Physics, talks to Matin Durrani about his career in physics, the value of universities to a modern economy and how the IOP's new strategy seeks to make physics open to all

Founded in 1920, the Institute of Physics has had some high-flying presidents over the years. Early luminaries included Ernest Rutherford, J J Thomson and Lawrence Bragg, while more recently the presidency has been held by the likes of Jocelyn Bell Burnell, Julia Higgins and Sheila Rowan. The current incumbent is Keith Burnett, an atomic physicist who spent more than a decade as vice-chancellor of the University of Sheffield in the UK.

He studied at the University of Oxford and worked at the University of Colorado at Boulder and Imperial College London, before returning to Oxford, where he was head of physics in the mid-2000s. But despite a career spent almost entirely at top universities, Burnett is not a distant, elite figure. He grew up in the valleys of South Wales and revels in the fact that his cousin Richie Burnett was World Darts Champion in 1995.

Physics World caught up with Burnett to find out more about his career and vision for physics.

Schmidt Science Fellows

Forward looking Originally from South Wales, Keith Burnett is an atomic physicist whose two-year term as president of the Institute of Physics began in October 2023.

What originally sparked your life-long interest in physics?

I grew up in a mining valley in South Wales, which was a wonderful place with a really cohesive community. It was at the time of the Apollo space programme – oh my goodness, the excitement. You could see the possibilities and I was fascinated by the idea of space. But one thing I did have was a wonderful teacher in school – Mr Cook. Also, my father worked for a small engineering company that made ceramics. So I just loved the idea of science from the very beginning.

You went on to study at Oxford, where you did a PhD in atomic physics. What attracted you to that field?

I had absolutely wonderful undergraduate lecturers and teachers – one being another Welshman, Claude Hurst. There was also Colin Webb, who later started Oxford Lasers. He was an amazing undergraduate teacher at Jesus College and he really inspired me. In fact, he then passed me on to one of his buddies, Derek Stacey. The group had been founded by Heini [Heinrich] Kuhn, who was an emigré scholar from Germany, and had a wonderful tradition in precision atomic physics.

Did the commercial side of physics ever appeal in terms of your own career?

Not so much, but I did really admire what Colin was doing because he was very early in terms of commercialization. People wanted the type of excimer lasers he was making in the lab. In fact I just got an e-mail from him. He's retired but very pleased that Oxford Lasers has won a good contract for doing semiconductor work. So I very much admire the applications of lasers and optics.

You were around in the 1990s at the time Bose–Einstein condensation was first observed in the lab. It was a peak period for atomic physics wasn't it?

I was actually on the search committee that hired Carl Wieman to [the University of Colorado at] Boulder, where I was an assistant professor at the time. Carl joined the faculty and worked with Eric Cornell to make a Bose–Einstein condensate. I was tracking that very closely. It was an absolutely wonderful time because it went from "No-one thinks you can make it" to "Maybe they've made it" and then "Wow, it's really big and juicy and we can do great stuff with it."

Would you say Eric Cornell and Carl Wieman were worthy winners of the Nobel Prize for Physics in 2001?

Yes. They won it with Wolfgang Ketterle. It was a remarkable story with twists and turns because the person who developed the ideas behind [laser] cooling was Dan Kleppner at MIT. He was the first to develop hydrogen cooling with Tom Greytak. But what is really important is that the people at MIT taught other people elsewhere how to do it. Because of that, they progressed much faster and were able to learn from one another. It shows that if you don't have trust and the ability to exchange ideas, everything slows down.

After spells at Imperial College and then back at Oxford, you became vice-chancellor at the University of Sheffield. How did that come about?

I was about 49 when they said "Will you be head of physics at Oxford?" And I thought

"Yeah, that'll be amazing!" So I did that and it was very perplexing but wonderful – an amazing department. I did that for a year. But the person who inspired me [to move to Sheffield] was actually an ex-president of the IOP – and the previous vice-chancellor of Sheffield – Gareth Roberts [who died in 2007]. He's another Welshman, though from north Wales, which is very different from south Wales – they play soccer, not rugby – but still Welsh. I was very poor at rugby. But my cousin Richie was World Darts Champion in 1995. He's the really well-known Burnett in the valley. Not me!

So what did Gareth Roberts say to you?
Well, I'd worked with Gareth at Oxford and he said "You should really think about it." Sheffield is a city bathed in the traditions of making steel and metallurgy. So I thought I would love being part of the civic life of the city. I also felt this was a university that does wonderful things for its citizens and students. The other thing is that my daughter had gone to Sheffield before me – she's an architect there so I always say I follow in my daughter's footsteps.


University of Sheffield

Boom times The UK higher-education system has been hugely successful in recent decades. When Keith Burnett left the University of Sheffield in 2018 after more than 10 years as vice-chancellor, it had nearly 8000 staff and a turnover of £500m. Money earned on the back of growing numbers of international students has helped universities like Sheffield to fund new projects, such as its Diamond study and engineering facility pictured here.

As vice-chancellor at Sheffield, you were firmly opposed to the principle of student tuition fees. Why was that?
Higher education is not just for the individual. It has consequences for society and for business too. If you say "No, it's just an individual choice whether someone goes to university and pays a fee", well that can work to a certain extent. But you cannot then be sure you'll have enough scientists to work in, say, industry or defence. As a country, we used to roughly balance the system in terms of where people went. But now it's a free-for-all in terms of choice, which is bad if we need more people in science and engineering. Tuition fees also fundamentally change the relationship with students. I disagreed with fees when they came in and I still disagree with them now.

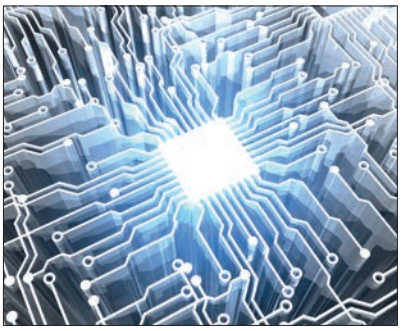
The UK university sector has expanded hugely over the last 20 years thanks to a huge rise in student numbers and the trebling of tuition fees in 2012. Has that been good or bad?
The big thing that happened during my time at Sheffield was the increase in student tuition fees [to £9000]. I was very much against the increase, which wasn't a popular [position to hold] among many of my vice-chancellor colleagues. In fact, I remember being pressured by Number 10 to sign a letter with other Russell Group universities to support the rise. I knew it was going to be a major burden on households and we're now in a situation where the UK has to write off £12bn [from students who never earn enough to pay their loans back]. We've got a very bad investment portfolio and the students have got debt. It's been a disaster.

If you look at a place like Sheffield, students bring enormous benefits – vitality, money, inward investment

Tuition fees haven't risen by much over the last decade and many universities have come to rely on the higher fees paid by international students. How has the growth in foreign students affected the higher-education sector?
International student fees used to be a top-up. When I was at Sheffield, we used them to build a new engineering teaching lab, known as the Diamond. But nowadays the income from international students is pretty much built into the fabric – in other words, without their fees you can't run a university. We have some amazing physics departments in this country, but the tap that feeds them is actually undergraduate physicists, cross-subsidized by international students, especially from business schools, international relations and engineering. As a country, we need physics properly funded and less reliant on foreign students.

The rise in international students has also played a role in increasing immigration to the UK. Where do you stand in that debate?
If you look at a place like Sheffield, students bring enormous benefits – vitality, money, inward investment. Others may say "No, we don't like students taking accommodation" and things of that sort. If you talk to experts in immigration, it's far more neutral than people think. But the whole topic is inflammatory and it's difficult to get a balanced discussion of the advantages and disadvantages. There are, though, some incredible physics departments in the UK – look at the number of companies working with the University of Bristol in its quantum tech. This is a big potential business long term.

After Sheffield, you became involved in the Schmidt Science Fellows scheme – what's that all about?
It was an idea of [the US computer scientist] Stu Feldman, a long-term confidant of Eric and Wendy Schmidt – Eric being a former chief executive and chair of Google. Stu said "There ought to be a way in which people, once they've done their PhDs, can think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Making an impact The Institute of Physics, of which Keith Burnett is the current president, has three main strands to its new five-year strategy, which runs 2024–2029. They are: tackling the skills shortage and opening up opportunity; strengthening physics research, innovation and technology; and ensuring the social and economic benefits of physics are appreciated and widely understood.

more broadly rather than just carrying on in a particular thing." How, in other words, can we identify people across the world who've got fantastic ideas and then give them some freedom to move? So we – our team at Rhodes House in Oxford – select people with exciting ideas and help them choose where they might go in the world.

What's your role in the scheme?

My job is to mentor researchers in making this transition. Initially, I did all of the mentoring but now I have some colleagues. It can be all the way from handling financial issues to dealing with principal investigators to writing faculty applications. Over the last six years we've helped about 120 people across the world in different institutions. Some are now in national labs, while others have set up their own businesses. For me, it's the most wonderful job because I get to hear the issues that early-career scientists have, such as using machine learning in all sorts of things – imaging biomolecules, precision drugs, everything.

What are the challenges facing early-career researchers?

First and foremost, salaries. I think we're in grave danger of underpaying our early-career scientists. We also need to do more to help people with their work–life balance. The Schmidt programme does have generous parental leave. There's also the question of supporting and promoting people who work in interdisciplinary areas.

In October 2023 you started your two-year stint as IOP president. What are your priorities during your term in office?

The IOP has just launched its new five-year strategy and the big focus is the skills base of teachers and researchers. First, are we helping teachers enough – the people who help people get into physics? We need a strong pipeline of talent because physicists don't just stay in academia, they move into finance, industry, policy.

Second, we are very interested in influencing science – especially the green economy. We have to explain that it's physicists – working with engineers and chemists – who are at the core of efforts to tackle climate change.

We're also thinking more about how to make membership of the IOP more useful and accessible. It's not arrogance to think that someone with an awareness of physics is just that much better prepared for lots of things going on in the modern world.

How can members of the IOP get involved with helping put that strategy into practice?

Start by looking at the strategy, if you haven't already. If you're a member of a particular group or branch, then feed your ideas back to your representatives. Our influence as an institute is much more powerful if we're the convenors and co-ordinators of a more general effort. We can't do all the things, but our membership is big and strong. If you can't find somebody, contact me.

You feel strongly about the need for the physics community to be more diverse. How do you see physics evolving over the next few decades?

There's a wonderful book, *After Nativism*, that just came out by Ash Amin, who's a trustee of the Nuffield Foundation, which I chair. He argues that many of the things needed to make a just, equitable and diverse society are not being advocated, with many parts of society backing away from these issues. But the younger generation is utterly committed to a future that's more just, equitable and diverse. They've grown up freer of prejudice but also used to discussing these things more openly. They're not interested in many of the divisions that people would see in terms of labels of any sort. Any labelling of people due to race, ethnicity, sexual proclivity – anything at all – is an anathema and I personally find that inspirational. I really find that inspirational.

How can the IOP help with such issues?

One of the things that the IOP can do is say "Well, what are the advantages of a society of that sort?" Some people may accuse us of being a bunch of "woke liberals". We're not. We're just people who believe in justice and equity in society. But we're going have to work for it because, as a profession, we are a long way off equity and have great deficits in terms of inclusion. Going forward, we will have a younger generation who will care much less about these issues because they won't see them. In fact, they'll find it very strange that there was a time when the IOP didn't represent society as a whole.

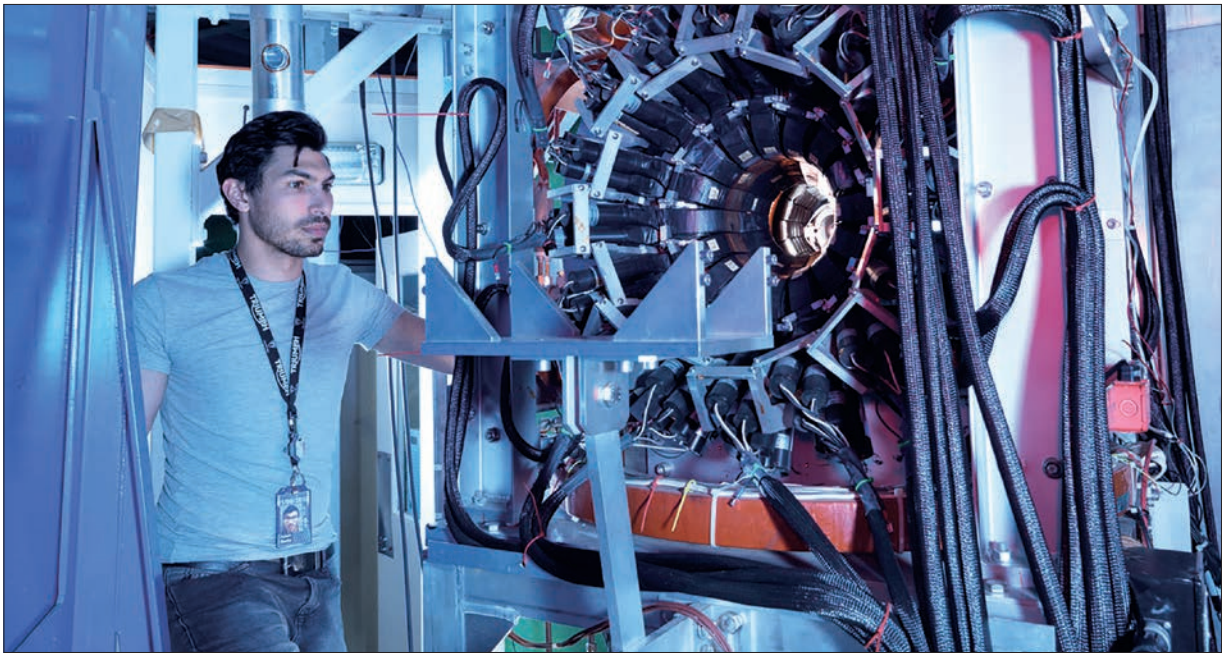
What are the benefits of a more equitable and inclusive physics community?

The advantages are huge. You know, if you exclude groups of people because of the labels you attribute to them, you're "deleting" people who could be powerful, influential and helpful for physics. You're just wasting people. I have this absolute commitment that the broader we are in terms of our people, the better, the more just and the more powerful we will be. I think our community wants that. Some won't; some people might have a more traditional view of what society is. But it's our duty and our incentive to say why we want a more just society – after all, it's smarter, more powerful, more fun.

● To hear a full-length version of this interview, listen to the *Physics World Weekly* podcast of 15 March 2024

Matin Durrani is editor-in-chief of *Physics World*

Embracing neurodiversity in neutron science



Science and Technology Facilities Council

Keeping busy Alongside his work at the ISIS Neutron and Muon Source in the UK, Adam Berlie is chair of the UKRI Disability Matters network.

Adam Berlie is a muon instrument scientist at the ISIS Neutron and Muon Source in the UK, having done postdocs in China and Australia. He talks about his career so far, what it's like to be a neurodivergent researcher, and his role as chair of the UKRI Disability Matters network

It was during my PhD studying metal-organic magnets at Durham University, UK, that I first started to realize that my approach to research made me different from my peers. I liked to work on lots of different projects at once, I was able to quickly switch between tasks in a way that other people sometimes struggled to understand, and I enjoyed pulling together lots of different strands of research rather than focusing on the details of a single project. Looking back, I recognize that this was a sign of neurodivergence – in my case dyslexia and Attention Deficit Hyperactivity Disorder (ADHD) – though I wasn't aware of this at the time.

Fortunately, I had two fantastic supervisors who encouraged my ability to see the big picture and I completed my PhD in 2013. However, having this kind of support hasn't always been my experience. Though I now work as a researcher, as a teenager I wasn't allowed to do a maths A-level and I was discouraged from doing physics because I wasn't seen as being "quick and able" enough to cope with these subjects. I have seen that many disabled scientists still feel that they have to camouflage and try to fit in, even if this negatively impacts their work. But neurodiversity has shaped my career; it has not only determined my choice of research projects but has also led me to my current role as the chair of the Disability Matters network at UK Research and Innovation (UKRI) – the umbrella body for the UK's main research funding councils.

A different perspective

In fact, some people had originally discouraged me from doing a PhD in the first place. My first degree was in chemistry and my cho-

sen path meant switching to physics at postgraduate level, which sometimes made me feel alienated from my colleagues.

However, I drew a lot on my knowledge of chemistry during my PhD, and I think that coming in with a different perspective benefited my work. In addition, being neurodivergent made the transition easier because I was used to switching between subjects and adapting to unfamiliar ways of thinking. My experience underscores why it's so important to include people from diverse backgrounds in scientific research. This is true not only for subject area and neurodivergence but also for other characteristics like race and gender.

After my PhD, I took a postdoc position in China, studying organic-based magnetic and superconducting materials under high-pressure conditions. I worked at the Institute of Solid State Physics in Hefei, part of the Chinese Academy of Sciences. I then did a second postdoc in Australia, in a role that was split between the Australian National University and the Australian Nuclear Science and Technology Organisation (ANSTO). I was involved in a huge range of research projects – I investigated solid-state organic and inorganic materials using techniques ranging from neutron spectroscopy to electron-spin resonance. But while I was there, I started to realize the limitations of postdoc work – producing results and pursuing the interests of someone else – when I was so driven by my own passions.

On returning to the UK in 2015, I joined the ISIS Neutron and Muon Source, and I've been here for eight years. Now I am building my own research programme, with the freedom to create a diverse and exciting portfolio, stretching from molecular and physical chemistry to quantum materials.

Tackling barriers for disabled scientists

However, there is still a lot to be done for neurodivergent researchers in the UK. For example, people with ADHD may struggle to manage organizational tasks, and I'm still pushing back against the idea that just because some things – such as writing and replying to e-mails – take longer for me than my neurotypical colleagues, I somehow haven't earned my place as a researcher.

This frustration led me to become involved in disability advocacy in my workplace. The research sector is so important, and when you encounter barriers you have the opportunity to stand up and demand change.

That's where my work as chair of the UKRI Disability Matters network comes in. The network spans all of UKRI, encompassing research councils and facilities including the ISIS Neutron and Muon source. The network was set up in 2021 to make UKRI a more disability-inclusive workplace.

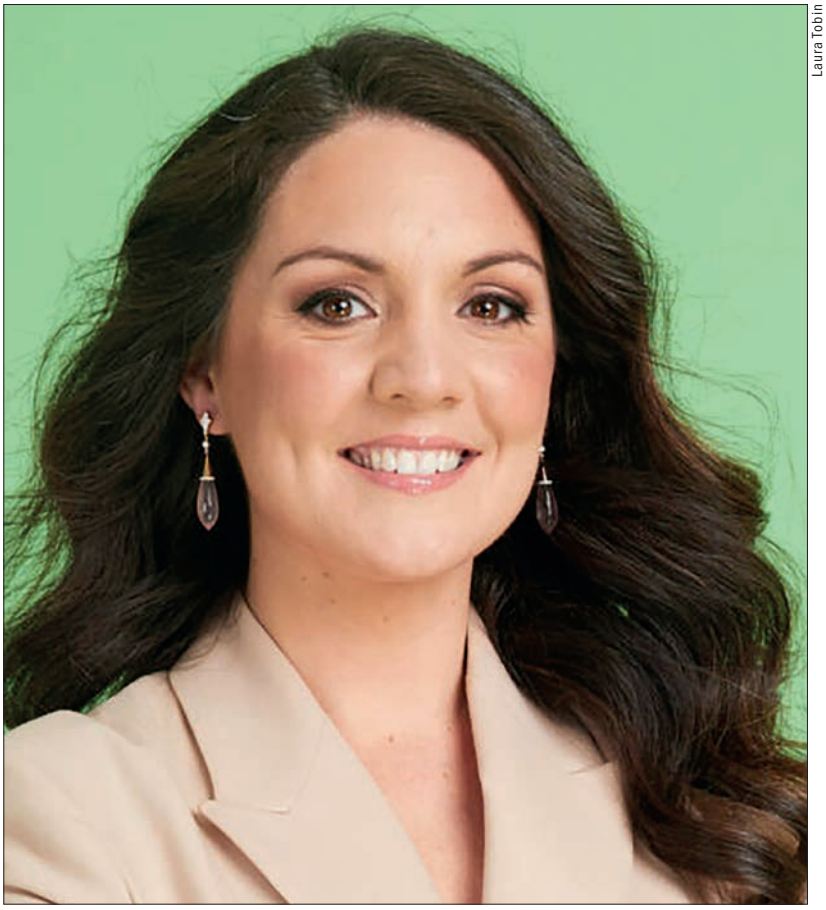
I have found that many workplaces want to support disabled people, but they often don't know what to do. One of our roles is to provide this expertise, as well as be a safe space for disabled colleagues to voice their concerns. As a researcher at the ISIS Neutron and Muon source, I also have the opportunity to put my beliefs into practice and foster a supportive environment for my colleagues. It's important to take the initiative and ask people whether they have everything they need, and we should be willing to listen and make adjustments. Diversity of thought benefits everyone, but when the focus is on the short-term costs of making changes, disabled people are often deterred from asking for what they need.

My experience shows that it is individual researchers themselves who understand what they need to succeed better than anyone else. That's a message I want to share with others, and I am always happy to talk about my experience as a disabled researcher with individuals and organizations. Being the chair of the UKRI Disability Matters network is one of the proudest parts of my career.

Adam Berlie is a muon instrument scientist at the ISIS Neutron and Muon Source in Oxfordshire, UK, and chair of the UKRI Disability Matters network

Laura Tobin won't stop talking about climate change

Laura Tobin, the meteorologist and weather presenter for *Good Morning Britain*, talks to Katherine Skipper about her love of physics, why she's always over-prepared, and her mission to report on the climate crisis



Laura Tobin

Rain or shine Laura Tobin has faced challenges in her career, but she's glad she embraced the opportunity to become a broadcast meteorologist.

At the start of her career, Laura Tobin was adamant that she would never be a weather presenter. A trained meteorologist, she was sick of being asked "Are you going to be on TV?" as a joke, aware that it was a comment on her gender as much as her job. "They're suggesting that you're going to stand there, point at a screen, and not be credible," she says.

Today, however, Tobin is a regular fixture on television screens across the UK. Since 2012, she has been a meteorologist and weather presenter for the broadcaster ITV. She says she is grateful she took a chance in her career: "You should never say never. It's good to give something a go."

Prepared for anything

Tobin's career began with a degree in physics and meteorology at the University of Reading, which she completed in 2003. She actually failed the first year of her physics

A level (the physics qualification she needed to go to university), but something "clicked" in her second year; she fell in love with the subject and did well in her final exams. "It's integral to know physics to be able to forecast the weather," says Tobin. "You need to be able to model the atmosphere and understand how it moves. The atmosphere is essentially a fluid so large parts of my degree were fluid dynamics."

After graduating she joined the MET Office – the UK's national meteorological service – as a forecaster. Based in Cardiff, Wales, her work was used to produce local weather services including radio bulletins and forecasts for renewable energy generation, road gritting and hill walking conditions.

This meant that long before she worked in front of a camera, Tobin had to present her work in a way that anyone could understand, which she says was a challenge at first. "When you're taught scientifically about the weather you have to change the way you speak," she says.

In her next role, Tobin had to adapt her forecasts to a very different audience. She worked at the Brize Norton Royal Air Force base in

Oxfordshire, UK, where she briefed pilots on the weather conditions and delivered reports for the British Forces Broadcasting Service. However, it took her a while to be accepted into the team: "They used to ask me really ridiculous questions. They used to try and catch me out because they wanted to see if I knew what I was talking about because I was a girl and I was young".

Luckily, Tobin did know what she was talking about. In fact, she has taken a positive lesson from the experience and says she still always over-prepares for any questions that might come her way.

A change of direction

When she had been at Brize Norton for five years, Tobin heard that the BBC, a UK public service broadcaster, was recruiting television weather presenters. Despite her earlier misgivings, she decided to give it a go.

When she saw firsthand what the job entailed, she was shocked, "I realized that I had a misconception of what a TV weather presenter was," she says. The television meteorologists were skilled broadcasters who could deliver regular weather reports in multiple genres, but they also had to understand the science behind everything they said, and they had to be ready to comment on everything from hurricanes to NASA launches.

Tobin took the role and stayed at the BBC for four years before moving to ITV, where she now works on the breakfast programme *Good Morning Britain*. She has never looked back, but the transition to broadcasting wasn't seamless. When she started at the BBC, her forecasts were prerecorded and she would often have to do many takes to get them right. She had scientific knowledge but effectively presenting what she knew on live television was a skill she had to learn on the job.

> You should never say never. It's good to give something a go

Every weekday morning, Tobin has just a few minutes to give viewers all the information they need about the day's forecast. This can be a challenge, but she says it's the most effective way to communicate, "I think if I spoke for longer than a minute on a climate report, I would lose people. You need to be succinct."

A new mission

In Tobin's early days as a television meteorologist she would occasionally report on an extreme weather event like record rainfall or temperature. These events have grown more and more frequent and now, as she points out, "they're happening so often that you can't report them all". Today, viewers don't just watch Tobin to decide whether to pack sunscreen or an umbrella, they look to her for credible information about the climate crisis.

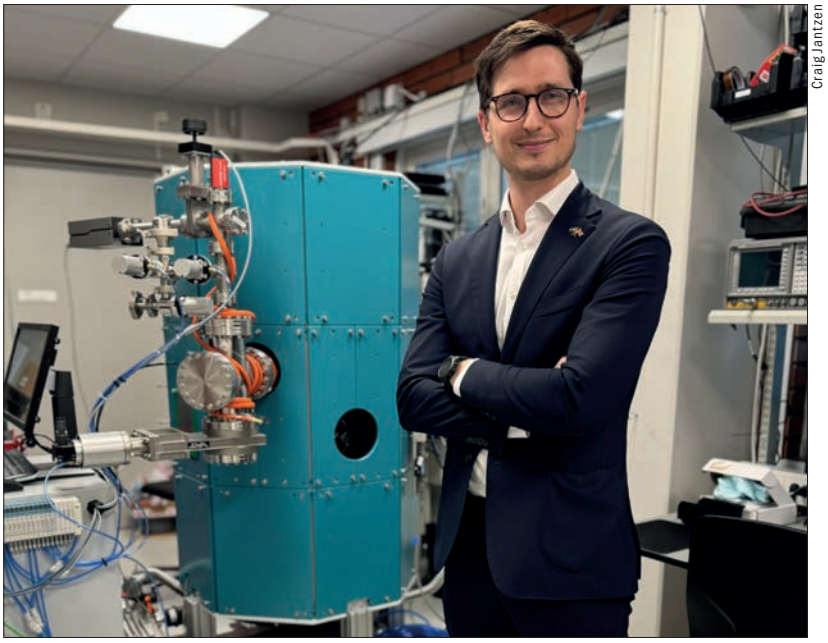
In September 2021, Tobin travelled to Svalbard in the North Pole to report on the effects of climate change for ITV. In one video she stands on what was once the edge of a glacier and explains that in the last 40 years the ice has retreated by half a kilometre. Confronted firsthand with the effects of global warming, Tobin is visibly emotional as she delivers one report to viewers.

But Tobin isn't all "doom and gloom" – she is passionate about raising awareness of the climate crisis because she believes the people who watch her on television can make a difference. Despite facing a backlash from climate change deniers, she is not deterred, and raising awareness of climate change is now Tobin's mission: "I'd like to hope that I'm inspiring people to make a change."

Katherine Skipper is a features and careers editor of *Physics World*

From nuclear science to diplomacy

Craig Jantzen is the first secretary and regional manager for the UK's Science Innovation Network in the Nordic and Baltic regions. As a former nuclear scientist, he talks to Katherine Skipper about his varied career, how he learned to make mistakes, and why he thinks scientists can make great diplomats



Craig Jantzen

Fusing science and diplomacy Craig Jantzen makes a visit to a fusion physics laboratory at the KTH Royal Institute of Technology in Stockholm.

When Craig Jantzen was a PhD student at the University of Manchester in the UK, he used to go to politics and economics lectures alongside his research into nuclear materials. Jantzen is fascinated by all things nuclear, but he also saw the PhD as an opportunity to broaden his horizons beyond science. "You're not drained from doing a nine-to-five job every day, and you're around people that want to learn constantly," he recalls.

Jantzen's PhD, which he finished in 2017, involved investigating materials for next-generation nuclear reactors. It has been proposed that molten chloride salts, which are excellent heat conductors, could be used instead of water as reactor coolants, but these salts are incredibly corrosive to metals. Jantzen was testing the corrosion of different metal alloys in molten chloride salts in order to identify optimal materials for these reactors. But he is now a diplomat working on science collaboration and policy for the UK government. Given his interest in politics, Jantzen's job might not seem surprising, but he emphasizes that his career has "not been a straight line".

Having worked in finance, energy and environmental policy as well as the UK government's COVID-19 response, Jantzen is currently based in Stockholm as the first secretary and regional manager for the UK's Science Innovation Network where he covers the Nordic and Baltic regions. The network aims to build collaboration, promote UK research and provide expertise to the government. He leads a team of trained scientists, many of whom have PhDs, using their research experience to address policy issues like AI and climate change.

Embracing change

Jantzen's first experience of what it would be like to work as a diplomat was sparked by a chance encounter at a conference during his PhD. He attended a talk by a speaker who had worked at the International Atomic Energy Agency (IAEA), which promotes the safe use of nuclear technologies. Jantzen was particularly intrigued to hear the speaker talk about nuclear safeguards, and in his second year, he did a six-month internship at the IAEA in Vienna, working in the same team that had responded to the Fukushima Daiichi nuclear accident in 2011.

After his PhD, Jantzen considered staying in academia, but decided that his skills would be of better use elsewhere: "I realized I like talking about science a lot more than I enjoy doing science". As it turned out, Jantzen's first job after his PhD was as a financial consultant for Capco in London. "I knew that I would learn a lot in that environment and that they give you a lot of responsibility", he says, "and I felt that was a good compliment to academic research". Indeed, he credits this experience

with getting him over some of the imposter syndrome he had from his PhD. With an emphasis on meeting deadlines, he had to let go of perfectionism and admit when he didn't know something, eventually realizing that this allowed him to learn much faster.

But after 18 months in finance, it was time for another change. Wanting to do something he'd find more fulfilling, Jantzen started applying for jobs in the UK government. However, his career in the civil service got off to a slightly bumpy start.

He had been offered a role working for the Department for Business, Energy & Industrial Strategy on the proposed Wylfa Newydd nuclear power station in North Wales. However, in January 2019 – less than a week before he was supposed to start – the project was suspended. Instead, Jantzen joined the Energy Strategy team in the same department where he worked on the UK's plan to reach net-zero emissions by 2050. His research experience had given him "a nuclear energy lens", but working with modellers and policy teams across technologies like carbon capture and offshore wind gave him a valuable crash-course in the wider energy landscape.

Far-flung ambition

Having previously enjoyed his stint overseas with the IAEA, Jantzen soon started looking for more international-facing roles. With the UK hosting the 2021 United Nations Climate Change Conference (COP26), he knew that international environmental affairs was something he wanted to be part of. In November 2019 Jantzen moved to the Government Office for Science where he worked on the development of the UK's COP26 science strategy. He also volunteered for the Scientific Advisory Group for Emergencies (SAGE) secretariat during the COVID-19 pandemic, where he co-led the epidemiology policy team and prepared advice that was given to the government.

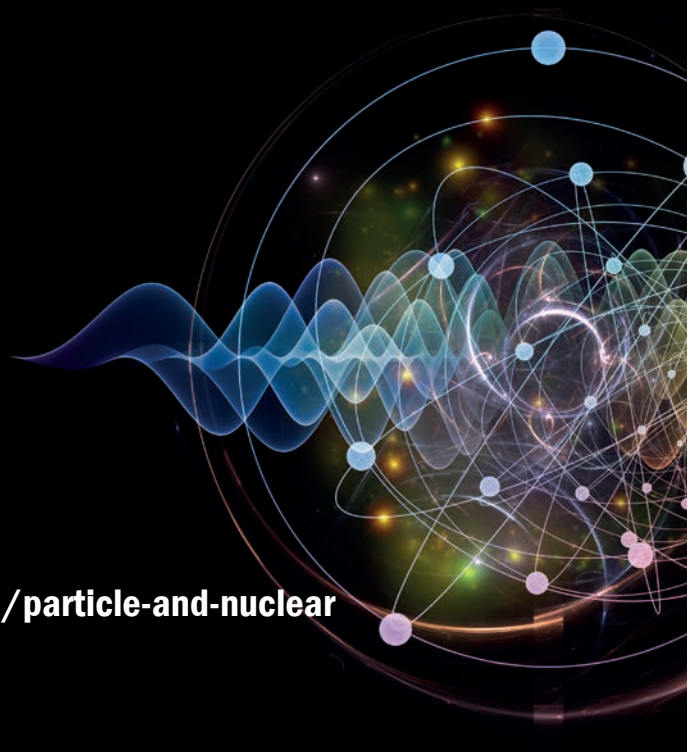
> A science background helps you do your job more effectively because you understand the technology, you're not intimidated by it

As it happened, when the opportunity came to move overseas, it was to return to the IAEA on a secondment funded by the UK government. In this role, he advised the IAEA on climate change during COP26 and COP27 – which was held in Egypt in 2022. This gave him the experience he needed to apply for full-time jobs overseas, which is how he ended up in his current position.

Now Jantzen's day could involve negotiating bilateral agreements, hosting an embassy reception, or running technology workshops. Jantzen believes his science background has been valuable to his career, saying "It helps you do your job more effectively because you understand the technology, you're not intimidated by it". As well as technical knowledge, scientists bring a diversity of thought that is valuable to a team, he believes.

Jantzen thinks his school and university-age self would be surprised at where his early interest in nuclear science has taken him: "I never imagined being a diplomat or working internationally." He had to gradually build up experience before making the jump to a diplomatic role overseas, and his advice to others who are interested in switching from science to diplomacy is not to be deterred if it takes time, saying "I definitely saw stepping stones. I didn't know exactly what opportunity was going to come up, but when I did, I was just ready for it."

Katherine Skipper is a features and careers editor of *Physics World*



Sometimes nature surprises us

Particle physicist **Juan Pedro Ochoa-Ricoux** talks to Katherine Skipper about how the next generation of neutrino experiments will test the boundaries of the Standard Model

JUNO/Yuexiang Liu

Breaking new ground Particle physicist Juan Pedro Ochoa-Ricoux during the construction of the Jiangmen Underground Neutrino Observatory (JUNO).

It was a once-in-a-lifetime moment during a meeting in 2011 when Juan Pedro Ochoa-Ricoux realized that new physics was emerging in front of his eyes. He was a postdoc at the Lawrence Berkeley National Laboratory in the US, working on the Daya Bay Reactor Neutrino Experiment in China. The team was looking at their first results when they realized that some of their antineutrinos were missing.

Ochoa-Ricoux has been searching for the secrets of neutrinos since he began his master's degree at the California Institute of Technology (Caltech) in the US in 2003. He then completed his PhD, also at Caltech, in 2009, and is now a professor at the University of California Irvine, where neutrinos are still the focus of his research.

The neutrino's non-zero mass directly conflicts with the Standard Model of particle physics, which is exciting news for particle physicists like Ochoa-Ricoux. "We actually like it when the theory doesn't match the experiment," he jokes, adding that his motivation for studying these elusive particles is for the new physics they could reveal. "We need to know how to extend [the Standard Model] and neutrinos are one area where we know it has to be extended."

Because they rarely interact with matter, neutrinos are notoriously hard to study. Electron antineutrinos are however produced in measurable quantities by nuclear reactors and this is what Daya Bay was measuring. The experiment consisted of eight detectors measuring the electron antineutrino flux at different distances from six nuclear reactors. As the antineutrinos disperse, the detectors further away are expected to measure a smaller signal than those close by.

However, when Ochoa-Ricoux and his team analysed their results, they found "a deficit in the far location that could not only be explained by the fact that those detectors were farther away". Neutrinos come in three types, or "flavours", and it seemed that some of the electron antineutrinos produced in the power plants were changing into tau and muon antineutrinos, meaning the detector didn't pick them up.

This transformation of neutrino type, also known as "oscillation", occurs for both neutrinos and antineutrinos. It was first observed in 1998, with the discovery leading to the award of the 2015 Nobel Prize for Physics. However, physicists are still not sure if antineutrinos and neutrinos oscillate in the same way. If they don't, that could explain why there is more matter than antimatter in the universe.

JUNO/Yuexiang Liu

Science at work Juan Pedro Ochoa-Ricoux at the Jiangmen Underground Neutrino Observatory (JUNO) during its construction. Ochoa-Ricoux stands in front of the detector, a 35.4 m diameter sphere filled with 20 kilotonnes of liquid scintillator that will study neutrinos from nuclear reactors.

The mathematics of neutrino oscillation is complex. Among many parameters, physicists define an angle called θ_{13}, which plays a role in determining the probability of certain flavour oscillations. For differences in oscillation probabilities between neutrinos and antineutrinos to be possible, this quantity must be non-zero. When Ochoa-Ricoux was working on the Main Injector Neutrino Oscillation Search (MINOS) at Fermilab in the US for his PhD, he had found tantalizing but inconclusive evidence that θ_{13} is different from zero.

The memorable meeting Ochoa-Ricoux recalled at the start of this article was, however, the first moment he realized "Oh, this is real". Their antineutrino deficit data eventually proved that the angle is about nine degrees. This discovery set the stage for Ochoa-Ricoux's career, which, a little like the oscillating neutrino, he describes as a "mixture of everything".

The asymmetry between antimatter and matter is one of the biggest mysteries in physics and in the next four years, two experiments – HyperKamiokande in Japan and the Deep Underground Neutrino Experiment (DUNE) in the US – will start looking for evidence of matter–antimatter asymmetry in neutrino oscillation (Ochoa-Ricoux is a member of DUNE). "Had θ_{13} been zero" he says, "my job and my life would have been very very different".

All hands on deck

Ochoa-Ricoux wasn't just analysing the results from Daya Bay, he was also assembling and testing the experiment. This was sometimes frustrating work – he remembers having to painstakingly remeasure detector components because they wouldn't fit inside the machine. But he emphasizes that this was an important part of the Daya Bay discovery. "On the one hand you analyse the data, but before you can do that, you actually have to build the apparatus," he says.

> On the one hand you analyse the data, but before you can do that, you actually have to build the apparatus

While Ochoa-Ricoux now spends much less time climbing inside detector equipment, he is actively involved in designing the next generation of neutrino experiments. As well as DUNE, he works on Daya Bay's successor, the Jiangmen Underground Neutrino Observatory (JUNO) in China, a nuclear reactor experiment that is projected to start taking data at the end of the year.

The first neutrino oscillation measurement was made in 1998 by the Japanese researcher Takaaki Kajita, who would later share the 2015 Nobel Prize for Physics for his work. However, the experiment where Kajita made this observation, called Super-Kamiokande, was originally designed to search for proton decay.

Ochoa-Ricoux thinks that DUNE and JUNO need to be open to finding something equally unexpected. JUNO's main aim is to determine which neutrino mass is the heaviest by measuring oscillating antineutrinos from nuclear power plants. It will also detect neutrinos coming from the Sun or the atmosphere, and Ochoa-Ricoux thinks this flexibility is vital.

"Sometimes nature will surprise us and we need to be ready for that," he says, "I think we need to design our experiments in such a way that we can be sensitive to those surprises."

Exploring the unknown

Experiments like DUNE and JUNO could change our understanding of the universe, but there is no guarantee that neutrinos hold the key to mysteries like matter–antimatter asymmetry. There's therefore pressure to deliver results, but Ochoa-Ricoux is excited that the field is taking leaps into the unknown.

He also argues that as well as advancing fundamental science, these projects could lead to new technologies. Medical imaging devices like MRI and PET scanners are offshoots of particle physics and he believes that "When you understand your world better, sometimes it's impossible to predict what applications will come."

However, at the heart of Ochoa-Ricoux's mindset is the same fascination with the mysteries of the universe that motivated him to pursue neutrino physics as a student. For him, projects like JUNO and DUNE can justify themselves on those grounds alone. "We're humans. We need to understand the world we live in. I think that's highly valuable."

Katherine Skipper is a features and careers editor of *Physics World*

The University of Birmingham has been challenging and developing great minds for more than a century. Characterized by a tradition of innovation, research at the university has broken new ground, pushed forward the boundaries of knowledge and made an impact on peoples' lives. We continue this tradition today and have ambitions for a future that will embed our work and recognition of the Birmingham name on the international stage.

Why study with us

The University of Birmingham has by far the longest-running pedigree of any UK university in teaching nuclear power degree courses. Our physics and technology of nuclear reactors MSc (PTNR) began in 1956, the same year as the world's first commercial nuclear power station, and continues to run to this day. Our MSc in nuclear decommissioning and waste management (NDAWM) is the only decommissioning-focused degree course in the UK. Birmingham also runs the biggest nuclear-engineering undergraduate programme in the UK.

Training and development

Our nuclear programmes have been refined over many years, and stem back to the early pioneers in the field when Otto Frisch (one of the discoverers of fission) and Sir Rudolph Peierls (one of the 20th century's great theoretical physicists) wrote their *Frisch–Peierls Memorandum* at Birmingham. We have a steering group of major UK nuclear-industry companies that provide funding to the MSc courses and guidance on course content and development. They also heavily recruit from us.

Graduate schemes

Our MSc courses are postgraduate programmes intended for graduates from most engineering and physical sciences disciplines.

What we are looking for

Graduates who have a good first- or second-class degree (or equivalent) in physics or a related subject. 2.2 degrees can be considered on a case-by-case basis. PhD possibilities may also exist if the student has funding.

Profile can be viewed at
physicsworld.com/jobs

LOCATION
Birmingham, UK

NUMBER OF RESEARCHERS
The University of Birmingham is the fourth largest university in the UK by student enrolment and therefore comprises a significant number of researchers

DESIRED DEGREE DISCIPLINES/CLASS
Physics or a related subject, at first or 2.1 level, although a 2.2 may be considered on a case-by-case basis

PRE-REQUISITES
Eligible to study in the UK

HOW TO APPLY
Online at **www.birmingham.ac.uk/schools/physics/postgraduate/index.aspx**

CLOSING DATE
All year round

CONTACT
University of Birmingham
Edgbaston
Birmingham B15 2TT
UK
Tel +44 (0)121 414 4660
E-mail p.i.norman@bham.ac.uk
www.birmingham.ac.uk/schools/physics/postgraduate/index.aspx

We work across the UK, mobilizing the PhD community to support students who are less advantaged to access the most competitive universities and succeed when they get there.

Why work for us

The Brilliant Club's Researcher Development Programme offers PhD and early career researchers a meaningful, professionally developmental, paid tutoring opportunity.

Training with The Brilliant Club and working as a Scholars Programme tutor enables researchers to communicate their research to a non-specialist audience, gain valuable teaching and public-engagement experience, and deepen their knowledge of the UK education system.

Training and development

You will be supported to deliver university-style tutorials to small groups of pupils.

To support our tutors to be as effective as possible when working with our scholars, we offer a comprehensive and ongoing training package. All tutors will complete a hybrid training programme including online modules to be completed in their own time and at least one live online training day per year.

Our training consists of:

- Core pedagogy sessions focusing on course design, tutorial planning, pupil engagement, and assessment.
- Elective sessions that focus on topics such as the UK school system and teaching sensitive topics.
- Child protection and safeguarding.
- Social events.

What we are looking for

We are looking for PhD students and graduates who are keen to receive expert training and real experience to develop teaching and other transferable skills.

Our tutors earn from £572 per placement, plus an additional £124 for designing a new course and travel expenses (plus up to £80 London weighting), and join a nationwide community of like-minded researchers making a significant impact.

All researchers who work with us are asked on a termly basis whether they are available. The Brilliant Club team will then look to place every available tutor in a local school.

Profile can be viewed at **physicsworldjobs.com**

LOCATIONS
Across the UK

NUMBER OF EMPLOYEES
100 full-time staff, 1000 tutors

MAIN AREAS OF RESEARCH
University access and success, we welcome specialists in all academic areas

POSITIONS RECENTLY RECRUITED FOR
Tutors across our programmes: the Scholars Programme, Join the Dots and Make your Mark

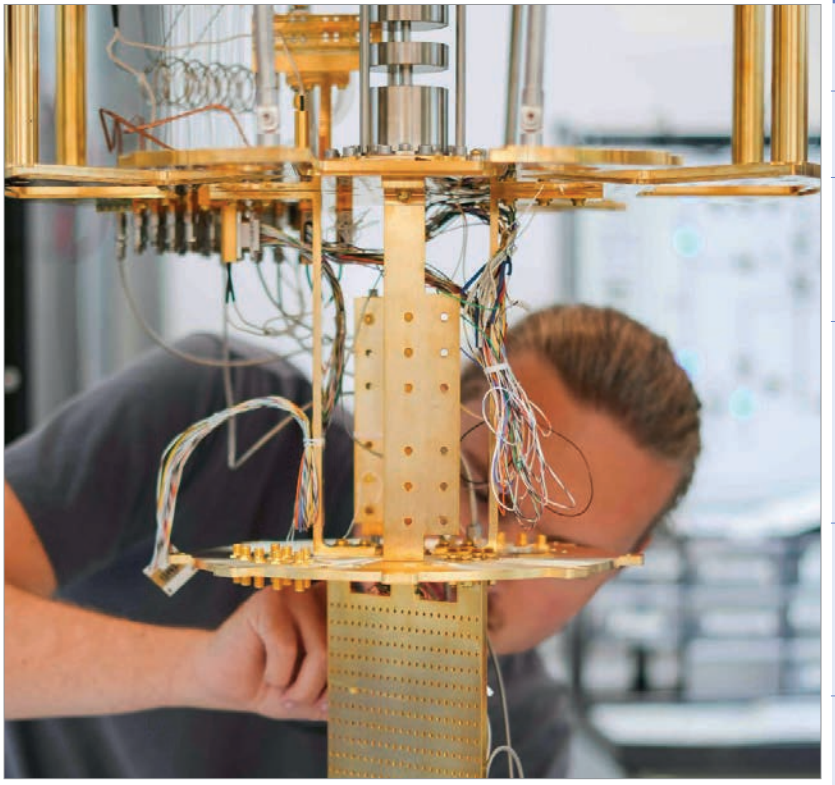
DESIRED DEGREE DISCIPLINES/CLASS
Current PhD student, PhD graduate

HOW TO APPLY
Visit **thebrilliantclub.org/become-a-tutor**

CLOSING DATE
Rolling application process, recruiting tutors for 2025/26 academic year

CONTACT
The Brilliant Club
Fivefields
8–10 Grosvenor Gardens
London SW1W 0DH
UK
Tel +44 020 3758 3991
E-mail apply@thebrilliantclub.org
www.thebrilliantclub.org

C12



Founded in January 2020, C12 is a Paris-based quantum computing startup born from the physics lab of École Normale Supérieure (an elite higher education institution based in France). C12 is building large-scale, error-corrected quantum computers using carbon nanotubes. Our approach blends ultra-pure materials and semiconductor technology to solve companies' most complex challenges. C12 has secured over €25 m in funding, has 47 employees, and holds private funding.

Why work for us

Our stellar team is made up of the world's most accomplished experts in quantum electronics and carbon nanotube science, coming from all over the world (15+ different nationalities). We are leading quantum's next material breakthrough, and we are just getting started.

C12 is the only startup to develop this type of disruptive technology with carbon nanotubes and an on-chip scalable architecture. We have our own state-of-the-art facilities (labs and ISO-7 certified cleanroom) right in the center of Paris.

Training and development

C12 invests in the professional development of its employees by inculcating collective and mandatory trainings in addition to a yearly dedicated individual budget for personal training.

Still primarily a research company but with a business focus, we pay for the publication of scientific papers by our employees.

The company also sponsors employees to relevant conferences anywhere in the world to gain more knowledge and insights. Furthermore, inventions by our employees are monetarily rewarded.

What we are looking for

Quantum enthusiasts who are seeking to join us on the pathway to bringing quantum computers to full scalability.

Profile can be viewed at
physicsworldjobs.com

LOCATION
Paris, France

NUMBER OF EMPLOYEES
47 and rapidly increasing

MAIN AREAS OF RESEARCH
Quantum computing, carbon nanotubes, nanofabrication, nanoassembly, spin qubits

POSITIONS RECENTLY RECRUITED FOR
Quantum measurement engineer, software engineer, quantum algorithm researcher, cleanroom technician, research engineer in carbon nanotube growth

DESIRED DEGREE & DISCIPLINES
This varies according to the role but generally a minimum of a Master's degree in the field of physics and engineering. For specific vacancies, a PhD may be required

HOW TO APPLY
Please apply directly on our website at **www.c12qe.com/join-us**

CLOSING DATE
All year round

CONTACT
C12 Quantum Electronics
26 rue des Fossés Saint-Jacques
75005 Paris
France
E-mail careers@c12qe.com
www.c12qe.com

We're a pioneer in the field of quantitative trading, founded in 1991. We are innovative, collaborative and passionate about what we do.

Why work for us

We create an environment for highly talented and passionate PhDs, IT engineers and other recognized experts to explore new ideas and challenge the norm. We are a Great Place To Work and welcome those who are intellectually curious and keen to see CFM's thinking, research and analysis come to life in a way that benefits our clients.

Training and development

At CFM we offer a completely integrated approach to training and learning about all aspects of our business whether it's scientific seminars and technical training or products teach-ins and innovation competitions. Professional and personal development are at the heart of our HR policies, which offer internal mobility to build experience and collaboration, external training for new skills and a variety of clubs and charity opportunities to encourage personal development.

What we are looking for

We are looking for great minds and team players to help us remain at the forefront of modern investment management. If you're someone who enjoys rising to a challenge, who pursues excellence with enthusiasm and perseverance, and who sees the value in collaboration and co-operation to uncover the best ideas, develop the best solutions and deliver the best results, then come join CFM.

Profile can be viewed at
physicsworld.com/jobs

LOCATIONS
Paris, France; New York, US; London, UK

NUMBER OF EMPLOYEES
350

MAIN AREAS OF RESEARCH
CFM conducts research on all aspects of the investment process: from data analysis to trade execution and portfolio construction algorithms. Our interests range from macro analysis (carbon strategies, country and sector analysis) to order books, from specific financial instruments to synthetic instruments

POSITIONS RECENTLY RECRUITED FOR
Quantitative researchers, IT and software engineers

DESIRED DEGREE DISCIPLINES/CLASS
PhD in physics, mathematics, biology, computer sciences, economics, with a strong emphasis on the numerical manipulation of data. No prior knowledge of finance is required

PRE-REQUISITES
Eligibility to work in the EU/US

HOW TO APPLY
Please visit **www.cfm.com**

CLOSING DATE
All year round

CONTACT
Capital Fund Management (CFM)
Rue de l'Université
75007
Paris
France
Tel +33 (0)1 49 49 59 49
E-mail careers@cfm.com
www.cfm.com

CARDIFF UNIVERSITY: SCHOOL OF PHYSICS AND ASTRONOMY

Welcome to Cardiff University's School of Physics and Astronomy, one of the most highly regarded departments in the UK for undergraduate and postgraduate studies. World-leading research lies at the very heart of what we do, recent breakthroughs include discovering possible signs of life on Venus. 99% of our submission was deemed world-leading or internationally excellent in the most recent Research Excellence Framework (REF). Our research power (an indicator of the scale and quality of our submission) has almost tripled since REF 2014.

Why study with us

We pride ourselves on nurturing a friendly and supportive environment, alongside excellent teaching, which is why *The Guardian University Guide 2023* ranked us 9th in the UK for physics degrees. Studying with us not only offers you the opportunity to gain a fundamental understanding of the universe, but also gives you the practical skills and ability to solve real-world problems. With state-of-the-art facilities, we attract multi-million-pound research funding from significant bodies such as government and international space agencies. Our pioneering research compliments the teaching on our degree courses, as students are taught by academic staff at the forefront of their scientific fields with a track record of teaching excellence, helping you to achieve your full potential.

Career prospects

Our exciting range of degree courses provide you with advanced and specialist skills to enhance your career prospects, and we provide extensive support to guide you on your chosen career path. Our courses are accredited by the Institute of Physics, allowing you to gain professional awards such as Chartered Physicist (CPhys) later in your career. We also offer the opportunity for a professional placement, a year in industry, or even a summer research placement based in the UK or abroad.

Postgraduate opportunities

Our broad range of MSc courses allow students from a range of backgrounds to specialise in physics, astrophysics, data-intensive physics/astrophysics, semiconductor physics or gravitational physics. We offer supervision and/or research projects in a range of areas including gravitational waves, astronomy, quantum devices and brain imaging. We have a range of PhD studentships and are the lead university for the Centre for Doctoral Training in Compound Semiconductor Manufacturing, offering fully funded studentships for selected students. Postgraduate students also have the chance to lead practical demonstrations for undergraduate students, as well marking their work, which can support your career prospects. Our Master's Excellence Scholarships are worth £3000 in the form of a tuition fee discount, as part of a £500,000 investment to support UK students. Further details can be found on our website.

Thinking of applying?

We welcome students with a range of qualifications and achievements. Simply head to our website for the exciting courses we offer.

Profile can be viewed at
physicsworldjobs.com

LOCATION
Cardiff, UK

NUMBER OF RESEARCHERS
58 academic staff

DESIRED DEGREE DISCIPLINES/CLASS
For undergraduate, generally A*AA-ABB. For postgraduates, generally 2.1 minimum in a physical science/engineering/mathematics degree

PRE-REQUISITES
Eligible to study in the UK

HOW TO APPLY
Postgraduates apply online at **www.cardiff.ac.uk/physics-astronomy**. Undergraduates apply through UCAS

CLOSING DATE
All year round

CONTACT
Cardiff University
School of Physics and Astronomy
Queen's Buildings North Building
5 The Parade
Newport Road
Cardiff CF24 3AA
Wales
Tel +44 (0)29 208 76457
E-mail physics-admissions@cardiff.ac.uk
www.cardiff.ac.uk/physics-astronomy

The European Southern Observatory's (ESO) mission is to design, build and operate the world's most advanced ground-based optical and infrared observatories, and to foster international collaboration for astronomy. Our vision is to advance humanity's understanding of the universe by working with and for the astronomy community, providing it with world-class telescopes and instruments.

Why work for us

You would be working together with our >700 staff members and thousands of collaborators in Europe, Chile, Australia and beyond, developing the largest optical telescope in the world, collaborating on high-tech instruments for our three observatories, operating and maintaining them 24/7, supporting astronomers in their observations, while you carry out research in astrophysics and R&D. You would help us ensure that ESO remains at the forefront of astronomical investigations, infrastructure and instrumentation.

Training and development

ESO promotes a positive learning culture to support its mission, values and goals. Our comprehensive learning and development package includes management and leadership training, behavioural and technical skills training, and language training. We strive to foster a work environment where all staff have opportunities to develop their skills and competencies. We encourage our staff to proactively manage their career advancement and facilitate personal career development in partnership with them.

Postgraduate opportunities

We offer:

- Five- to six-month internships for students at the end of their university studies (Master-level or possibly Bachelor-level) in astrophysics, engineering and science communication.
- PhD studentships and postdoctorate fellowships in astrophysics and engineering for up to three years.

These programmes are open to all nationalities with a preference for applicants from ESO member states.

What we are looking for

For our postgraduate schemes we are looking for dynamic young individuals with a good deal of team spirit, curiosity and eagerness to learn, who can bring new ideas to our R&D programme. For our staff members, we are looking for motivated, experienced collaborators at various career levels, in different fields, including engineering, administration, finance, procurement, human resources. Astronomers need a PhD, engineers a university diploma.

Profile can be viewed at
physicsworld.com/jobs

LOCATIONS
Germany, Chile

NUMBER OF EMPLOYEES
c.700

MAIN AREAS OF RESEARCH
Engineering (all fields) and astronomy

POSITIONS RECENTLY RECRUITED FOR
We have recently recruited engineers (e.g. software, electronic, electrical, optical, mechanical), astronomers and administrative personnel

HOW TO APPLY
Please visit **https://recruitment.eso.org**

CLOSING DATE
All year round

CONTACT
European Southern Observatory (ESO)
ESO Headquarters
Karl-Schwarzschildstr. 2
Garching near Munich
Germany
Tel +49 089 32006 0
E-mail vacancy@eso.org
www.eso.org


Credit: ESA/Science

We are the European Space Agency and we drive cutting-edge developments that will help shape the future of this planet. Our continuing mission is to explore new worlds while protecting the one we live on. As the only end-to-end space agency, we bring countries across the globe together to investigate, develop and explore the cosmos for the peaceful benefit of everyone. We are dedicated to united space in Europe and united Europe in space.

Why work for us

Are you enthusiastic, curious, a team player and eager to work in an international setting? With its 22 Member States and 3000 staff members working across Europe in nine different locations, ESA is the only space agency of its kind and a unique place to work. Joining ESA means working on pioneering missions in a diverse and welcoming environment with great benefits as well as numerous services and activities provided on site.

Training and development

Working for ESA gives you access to a wide range of courses on different topics, from technical training to project and people management, as well as access to top experts in various space-related disciplines.

Graduate schemes

Our six entry-level and research programmes are the perfect springboard for a career in the space sector.

- **Student Internships** are open to students still enrolled at university. Priority is given to Master's students, but Bachelor's students can also apply. Applications open in November each year.
- The **ESA Graduate Trainee Programme** is open to recently graduated Master's students. Applications open in February each year.
- **National Trainee Programmes** are offered to Master's graduates through bilateral agreements between ESA and certain participating countries.
- The **Junior Professional Programme** is designed for Master's graduates with 2–3 years of professional experience. The next selection is currently foreseen for 2025.
- Researchers can apply to ESA for **co-funding for space-related PhD and postdoc research activities**. Apply all year round at ideas.esa.int.
- The **Research Fellowship Programme** accepts applications from postdocs. Vacancies are published throughout the year, except for the Research Fellowships in Space Science, which open for application in August each year.

Who we are looking for

In line with our core business as a space science and technology organization, most ESA staff positions are in engineering and scientific disciplines. However, we also recruit for the business support services that are essential in helping us to achieve our goals.

Browse the positions we're currently recruiting for, or **set up a job alert,** at **jobs.esa.int**.

Profile can be viewed at
physicsworldjobs.com

LOCATIONS

France, the Netherlands, Germany, Spain, Italy, Belgium, UK

NUMBER OF EMPLOYEES

3000

MAIN AREAS OF RESEARCH

All engineering and science disciplines related to the space sector are covered at ESA, but those are not the only areas we recruit in. Check out our latest activities on our website – you may be surprised by the domains we cover and find something there for you, too

DESIRED DEGREE DISCIPLINES/CLASS

The majority of professional roles at ESA require a Master's as a minimum. For specific vacancies, a PhD may be required

HOW TO APPLY

Apply online at **jobs.esa.int**

CLOSING DATE

Vacancies are regularly published on our recruiting website. Most standard vacancies remain open for three weeks from the date of publication, while those for our entry-level programmes are usually open for four weeks

CONTACT

ESA Headquarters
8–10 Rue Mario Nikis
CS 45741
75738 Paris Cedex 15
France
Tel +33 1 53 69 76 54
E-mail esacareers@esa.int
www.esa.int

Institute of Physics' offices in King's Cross.

The Institute of Physics (IOP) is the professional body and learned society for physics in the UK and Ireland. We seek to raise public awareness and understanding of physics and support the development of a diverse and inclusive physics community. As a charity, we're here to ensure that physics delivers on its exceptional potential to benefit society.

Why work for us

As a society we face an unprecedented array of challenges. Globally, we need to address a changing climate and a growing population, to decarbonize economies, improve healthcare and ensure water, food and energy supplies. Domestically, we need to develop the next generation of industries to create jobs and improve productivity to safeguard citizens' futures.

Physics has a vital role to play in tackling these issues and helping make the UK and Ireland fit for a new industrial era of science, technology and engineering.

There's never been a more exciting time to join the IOP. We have an ambitious corporate strategy "Building the Future", that seeks to address these challenges, and you'll play a part in helping us to deliver it.

As well as a competitive salary and professional development opportunities, we offer employees a comprehensive benefits package including an excellent pension scheme, private medical insurance and generous annual leave. We also offer a range of other benefits including flexible working, Cycle2Work scheme and gym membership.

Learning and development

We really value our people and recognize the importance of a highly skilled and motivated workforce. We're committed to providing high-quality learning and development opportunities that help support your future career ambitions. As every employee has different needs, we vary programmes to suit you. This includes multi-session programmes, team workshops, and one-to-one coaching – all being a combination of internal and external provision. We also offer employee sponsorship for vocational and professional qualifications that are relevant to individual roles.

Profile can be viewed at
physicsworld.com/jobs

LOCATION
London, UK

NUMBER OF EMPLOYEES
150–175

POSITIONS RECENTLY RECRUITED FOR
We have recruited to a variety of positions across a range of departments including communications and marketing, HR, learning and skills, science and innovation, digital, membership and more

PRE-REQUISITES
Eligible to work in the UK or ROI as appropriate

HOW TO APPLY
Apply at **iopjobs.org/current**

CLOSING DATE
All year round

CONTACT
Human Resources
Institute of Physics
37 Caledonian Road
London N1 9BU
UK
Tel +44 (0)20 7470 4800
E-mail recruitment.london@iop.org
www.iop.org

LIV.INNO

LIVERPOOL CENTRE FOR DOCTORAL TRAINING FOR INNOVATION IN DATA INTENSIVE SCIENCE (LIV.INNO)

The Liverpool Centre for Doctoral Training for Innovation in Data Intensive Science (LIV.INNO) is an inclusive hub for training diverse cohorts of excellent students in data-intensive science. The centre has a focus on addressing the data challenges presented by research in astronomy, nuclear, theoretical, particle and accelerator physics.

Why study with us

Recent years have witnessed a dramatic increase of data in many fields of science and engineering, due to the advancement of sensors, mobile devices, biotechnology, digital communication and internet applications. If you are interested in working on some of the most advanced research and development challenges in data-intensive science with the UK's top experts in this field, then a PhD within LIV.INNO might be right for you.

Training and development

LIV.INNO offers its PhD students comprehensive training in data-intensive science through cutting-edge interdisciplinary research projects and a targeted academic training programme, complemented by secondments to national and international research partners and strong industry contributions. This framework will provide you with an ideal basis for driving science and innovation, as well as boost your employability.

The centre is supported by the Science and Technology Facilities Council (STFC) and hosted by the University of Liverpool and Liverpool John Moores University/ Astrophysics Research Institute.

What we are looking for

We are looking for dynamic, proactive PhD students who have a passion for data-intensive science with ideally with coding skills and experience in data analysis. We encourage in particular applications from women and other STEM minority groups.

LIV.INNO actively helps overcome barriers to access; qualifying students can receive additional funding for research-related travel costs. It is also possible to realize many of our PhD projects part-time, over a longer total period.

Profile can be viewed at
physicsworldjobs.com

LOCATION
Liverpool, UK

NUMBER OF RESEARCHERS
Around 12 per cohort

MAIN AREAS OF RESEARCH
Astronomy, nuclear, theoretical and particle physics, accelerator science, mathematics, computer science

POSITIONS RECENTLY RECRUITED FOR
We have successfully trained 36 students in our first CDT in data-intensive science (LIV.DAT), and the first LIV.INNO cohort started in October 2022

DESIRED DEGREE DISCIPLINES/CLASS
All engineering and science subjects: 2.1 honours degree (or equivalent)

PRE-REQUISITES
Eligible to study in the UK

HOW TO APPLY
For information on how to apply please visit our website **www.livinno.org**

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CONTACT
Liverpool Centre for Doctoral Training for Innovation in Data Intensive Science
Prof. Dr Carsten P Welsch
LIV.INNO Director
Oliver Lodge Building
Liverpool L69 7ZE
UK
Tel +44 79732 47982
E-mail c.p.welsch@liverpool.ac.uk
www.livinno.org

MANCHESTER 1824
The University of Manchester

The University of Manchester is recognized globally for its pioneering research, outstanding teaching and learning, and commitment to social responsibility. The Russell Group institution is ranked the 6th best university in the UK and 52nd in the world (Academic Ranking of World Universities).

Why study with us

- Our graduates are among the most targeted by UK employers, giving you the best start in your career (Graduate Market in 2023, High Fliers Research).
- Have the opportunity to make an ethical, social, and environmental difference in society through student volunteering, online courses, and activities.
- Manchester is rated the top UK city to live in (The Economist Global Liveability Index, 2022).
- We welcome students from 160 countries from all over the world each year, creating an exciting and friendly community.

Training and development

Whether you want to gain specialist knowledge in a specific area, brush up on your skills as a scientist or go into research, we have a taught Master's course in medicine for you. Manchester is home to both one of the largest medical schools in the UK and top researchers working at the forefront of the medical field. We offer postgraduate taught courses covering a wide range of disciplines for students from both medical and non-medical backgrounds.

Graduate schemes

Specialist courses cover occupational, aesthetic and musculoskeletal medicine, paediatric anaesthesia, and medical education. You'll be taught by a wide range of specialists. For example, students studying our Medical Physics in Cancer Radiation Therapy Master's learn from academics and clinical scientists in physics, engineering, biology and oncology. Depending on your area of interest, you'll have access to world-leading facilities such as our MR-Linac or proton therapy research facilities at The Christie.

What we are looking for

Manchester's pioneering Master's courses work across disciplines and draw on our world-leading research and strong links to global industry. You'll quickly develop skills and gain experiences that give you the power to make your mark and set you apart in the jobs market. If you're thinking of applying to Manchester, check out our website for the full range of courses available.

Profile can be viewed at
physicsworldjobs.com

LOCATION
Manchester, UK

NUMBER OF RESEARCHERS
Our community at Manchester includes more than 44,000 students, 12,000 staff, and 550,000 alumni from 190 countries. Across the Division of Cancer Science and the Manchester Cancer Research Centre there are >100 academics, researchers, and PhD students across the full spectrum of cancer research

MAIN AREAS OF RESEARCH
The University of Manchester's research beacons are examples of pioneering discoveries, interdisciplinary collaboration, and cross-sector partnerships that are tackling some of the biggest questions facing the planet. Our five research beacons include • Global inequalities • Advanced materials • Biotechnology • Cancer • Energy. The cancer beacon covers all aspects of cancer research, from basic discovery science to clinical studies, molecular cell biology to radiotherapy, and across a wide range of cancer types

DESIRED DEGREE DISCIPLINES/CLASS
For the MSc Medical Physics in Cancer Radiation Therapy, we are looking for students with a 2.1 or better undergraduate degree in physics or a related subject or comparable experience (full list on the webpage)

HOW TO APPLY
Visit **www.manchester.ac.uk/study/masters/courses/list/21394/msc-medical-physics-in-cancer-radiation-therapy/**

CLOSING DATE
All year round

CONTACT
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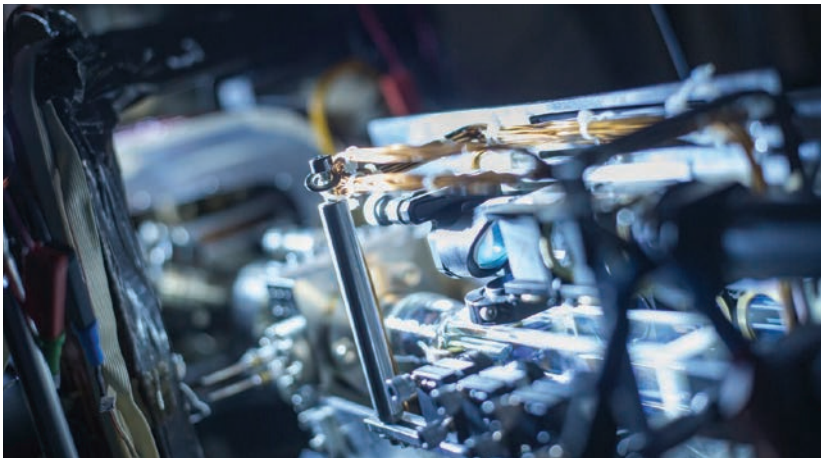
Tel +44 (0)161 306 6000
E-mail alan.mcwilliam@manchester.ac.uk
www.manchester.ac.uk

University of Nottingham
UK | CHINA | MALAYSIA

UNIVERSITY OF NOTTINGHAM: SCHOOL OF PHYSICS & ASTRONOMY



Welcome to the University of Nottingham School of Physics & Astronomy, where our teaching philosophy is deeply intertwined with our cutting-edge research. We are ranked 7th among UK physics departments in the last REF assessment, second only to Cambridge over the last three assessments for research quality. We are home to the Nobel prize for the development of MRI body scanners, have won recent awards for groundbreaking work in quantum technologies and dark energy, and host research fellows from the most prestigious research funders.

Why study with us

Our one-year MSc programmes in Quantum Science and Technologies (QST) and Machine Learning in Science (MLiS) offer world-class teaching from leading experts in rapidly growing fields. You'll gain hands-on experience using cutting-edge university facilities and have the opportunity to engage with key industry partners. Our flexible learning pathways will equip you with the knowledge, skills and connections for a successful career in the rapidly evolving fields of quantum technology and artificial intelligence.

Training and development

Our MSc programmes equip you with in-demand skills for the future.

The MLiS MSc focuses on applying machine learning and AI to real scientific problems, combining computational tools with statistical and physical principles. You'll develop strategies to analyse scientific data and acquire a broad set of transferable skills enhancing your employability in the rapidly growing field of AI.

The QST MSc covers quantum sensing, information, and metrology – areas of quantum technology already impacting society through brain imaging, gravitational sensing, and quantum communication. You'll also explore advanced topics like coherent quantum devices, light and matter, machine learning and scientific programming, preparing you for the evolving quantum industry.

Graduate schemes

Students in both the QST MSc and MLiS MSc have the opportunity to undertake selective, paid part-time internships with external partners, gaining valuable industry experience. The QST programme further enhances career prospects through workshops and seminars with industrial experts. Our MSc courses serve as excellent preparation for careers in industry or research, with the QST MSc particularly suited for those pursuing research careers in quantum science.

What we are looking for

Applicants for our MSc programmes should have an undergraduate degree at 2.1 (or international equivalent) in one of the following areas: physics, mathematics, computer science, chemistry or engineering.

Profile can be viewed at **physicsworldjobs.com**

LOCATION
Nottingham, UK

DESIRED DEGREE DISCIPLINES/CLASS
Prospective MSc students should have an undergraduate degree at 2.1 (or international equivalent) in one of the following areas: physics, mathematics, computer science, chemistry, engineering

PRE-REQUISITES
Eligible to study in the UK

HOW TO APPLY
Apply online at **www.nottingham.ac.uk/pgstudy/how-to-apply/taught.aspx**

CLOSING DATE
International students: 4 August 2025
UK students: 25 August 2025

CONTACT
University of Nottingham
School of Physics & Astronomy
University Park
Nottingham NG7 2RD
UK
Tel +44 (0)1159 513082
E-mail physics-reception@nottingham.ac.uk
www.nottingham.ac.uk/physics

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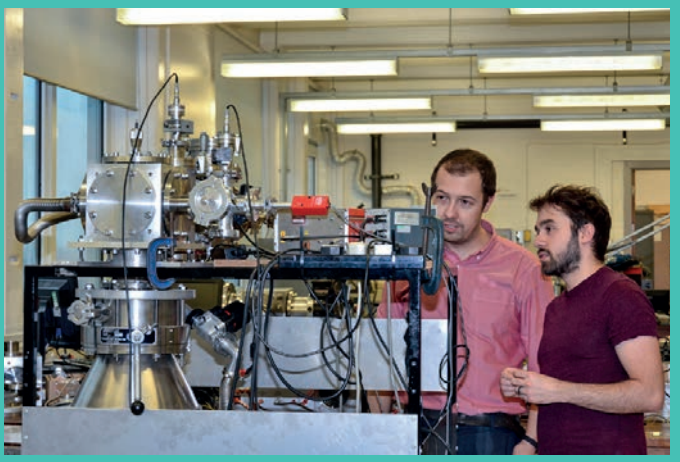

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For more information:

visit www.ntec.ac.uk

email: info.ntec@manchester.ac.uk

tel: +44 161 529 4799

UNIVERSITY OF OXFORD: DEPARTMENT OF ONCOLOGY

The Department of Oncology's mission is to improve cancer care through research and teaching. We employ multidisciplinary approaches from physics, biology, chemistry and mathematical modelling to investigate this. The department offers an established, world-leading, graduate training programme.

Why study with us

The MSc in medical physics with radiobiology is a one-year, full-time course delivered by world-leading academics and clinical scientists. The main aim of this course is to discuss how ionizing and non-ionizing radiation are used in clinical practice, both in the context of radiotherapy and medical imaging. This is combined with principles of radiobiology at molecular and cellular level, to give graduates a better understanding of the effects of radiation than is achieved in other medical physics courses. The course is accredited by the Institute of Physics and Engineering in Medicine (IPEM).

Training and development

You will take eight compulsory modules, which are delivered in two-week blocks, following on from each other:

1 Physics of Radiation Interactions
2 Molecular Radiation Biology
3 Radiobiology of Cells and Tissues
4 Radiation Safety
5 Ionizing Radiation Imaging Technologies
6 Radiation Therapy Physics
7 Non-ionizing Radiation Technologies
8 Translational Research Methods and Applications

Graduate schemes

This course is designed for individuals interested in careers in medical physics from either a clinical or academic research perspective, or in professions that require a knowledge of medical physics, such as radiation protection.

What we are looking for

As a minimum, applicants should hold or be predicted to achieve a first-class or strong upper second-class undergraduate degree with honours (or equivalent international qualifications) in physics or a closely related subject.

For more details on the course and requirements, visit:

- physicsworld.com/a/where-radiation-physics-meets-radiobiology-opening-up-diverse-career-paths-for-students
- www.oncology.ox.ac.uk/study-with-us/msc-in-medical-physics-with-radiobiology

Profile can be viewed at **physicsworldjobs.com**

LOCATION
Oxford, UK

MAIN AREAS OF RESEARCH
Medical physics and radiobiology

DESIRED DEGREE DISCIPLINES/CLASS
As a minimum, applicants should hold or be predicted to achieve a first-class or strong upper second-class undergraduate degree with honours (or equivalent international qualifications) in physics or a closely related subject

PRE-REQUISITES
Eligible to study in the UK

HOW TO APPLY
Apply online at **www.ox.ac.uk/admissions/graduate/courses/msc-medical-physics-with-radiobiology**

CLOSING DATE
Round 2 deadline is Spring 2025

CONTACT
University of Oxford
Department of Oncology
Old Road Research Campus Building
Oxford OX3 7DQ
UK
Tel +44 (0)1865 617331
E-mail msc.medphys@oncology.ox.ac.uk
www.oncology.ox.ac.uk

IPEM Masters Level Programme Accredited

Swiss Nanoscience Institute
Center of Excellence supported by the University of Basel and the Canton of Aargau

SWISS NANOSCIENCE INSTITUTE: UNIVERSITY OF BASEL

The Swiss Nanoscience Institute (SNI) at the University of Basel funds nanoscience research as part of an interdisciplinary degree course and a PhD programme, and in projects with industry partners. All students are widely integrated into the activities that address cutting-edge scientific topics in nanoscience and nanotechnology, embedded in classical disciplines such as physics, chemistry, biology, medicine and engineering.

Why study with us

The SNI offers internationally recognized, comprehensive, and hands-on degree programmes in nanoscience. The Bachelor's and Master's programmes attract highly motivated students and provide an excellent interdisciplinary education with a broad background in all the natural sciences in a very supportive environment.

In the SNI PhD School, students from all over the world work on a diverse range of projects; for example quantum computing, spintronics, molecular electronics, graphene, quantum sensing, nanocontainers for medical applications, solar cells, single-cell proteomics, nanofluidic devices, and many more. An established selection process involving external and internal senior scientists ensures excellent PhD projects.

Undergraduate and graduate students become part of the SNI community, with regular opportunities for personal development and scientific exchange within the whole SNI network, including all research institutions in north-western Switzerland.

Training and development

The SNI offers a broad interdisciplinary education with additional tailormade courses to improve personal development and skills such as scientific writing, communication, and presentation techniques. Small working groups guarantee personal and individual supervision.

The PhD programme includes regular SNI conferences, such as the SNI Annual Event and a winter school. These introduce students to the interdisciplinary scientific community and offer ideal opportunities for scientific and personal exchange, including with partners from industry.

Who we are looking for

Excellent and motivated undergraduate and graduate students who are not interested only in their particular working area, but are also fascinated by other fields in the natural sciences.

- If you are interested in the nanostudy programme, please visit **www.nanoscience.ch/studium**
- Information on new positions in the SNI PhD School and the online application tool are available from September to December every year at **www.nanoscience.ch/phd**

Profile can be viewed at **physicsworldjobs.com**

LOCATION
Basel area, Switzerland

NUMBER OF SNI MEMBERS
120

DESIRED DEGREE DISCIPLINES/CLASS
For PhD School: Master's degree in physics, chemistry, biology or related field. For study programme: high-school diploma

HOW TO APPLY
Apply online when new PhD positions are announced. New positions and the online application tool are available from September–December every year on **www.phd.nanoscience.ch**

CLOSING DATE
31 December 2025

CONTACT
Swiss Nanoscience Institute
University of Basel
Klingelbergstrasse 82
4056 Basel
Switzerland
Tel +41 61 207 3906
E-mail andreas.baumgartner@unibas.ch
www.nanoscience.ch

University College Dublin (UCD) hosts more than 30,000 students based in six colleges, of which 6000 are international students and 1500 are PhD students. The university is situated on a large modern campus located about 4 km south of the centre of Dublin. The College of Science comprises seven Schools: Biology and Environmental Science, Biomolecular and Biomedical Science, Chemistry, Computer Science, Earth Sciences, Mathematics and Statistics, and Physics.

Why study with us

The UCD School of Physics has a strong reputation for excellence in research and teaching, attracting students and staff of the highest international quality. The mission of the School of Physics is to promote knowledge and cultural and economic advancement, through excellence in research and teaching in physics (and related fields). The School is highly research active in fundamental physics, quantum science, space-related activities and the physics for health and medicine. It is one of the leading schools of physics in Ireland. Objectives of the school include:

- To continue to provide first-class education at undergraduate and postgraduate levels, in which teaching is delivered by research-active academic staff to equip graduates for careers in physics and in a wide range of related disciplines.
- To conduct excellent research in the school by establishing a critical mass of top-quality research teams and through increased funding from external sources.
- To strengthen existing collaborations and develop new research links with international centres of excellence in physics and science in general.

The UCD School of Physics is committed to being an inclusive, collegial and diverse environment in which all staff and students, regardless of gender, civil or family status, sexual orientation, religion, age, disability, race or membership of the Traveller community, are respected and valued, and given the necessary support to overcome barriers and to achieve their full academic potential. University College Dublin and UCD School of Physics are committed to fairness, consistency and transparency in selection decisions.

Graduate schemes

We offer MSc taught programmes in space science and technology, applied mathematics and theoretical physics, computational physics, medical physics, nanobioscience, nanotechnology, and physics.

We are also recruiting for PhD or MSc (research). Scholarships currently open: Thomas Preston Scholarship (PhD only), SIRAT Scholarship (PhD and MSc by research).

Profile can be viewed at **physicsworldjobs.com**

LOCATION
Dublin, Ireland

NUMBER OF RESEARCHERS
30 academic, 16 research,
13 administration/technical/other,
60 PhD students

PRE-REQUISITES
Eligible to study in the EU

HOW TO APPLY
Taught MSc: **www.ucd.ie/apply**
PhD/MSc (research): **www.ucd.ie/physics/study**
Currently recruiting: **www.ucd.ie/physics/research/vacanciesopportunities**

CONTACT
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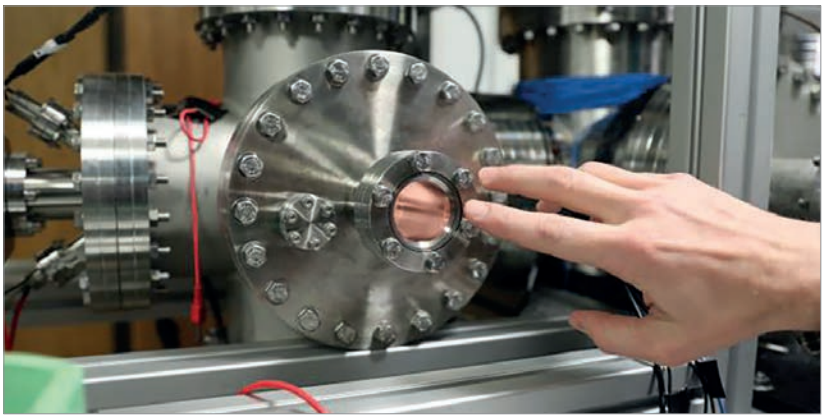
Tel +353 1 716 2210
E-mail bairbre.fox@ucd.ie
www.ucd.ie/physics
www.ucd.ie/aboutucd.htm

EPSRC Centre for Doctoral Training in
Quantum Computation and
Quantum Communications

UNIVERSITY COLLEGE LONDON: LONDON CENTRE FOR NANOTECHNOLOGY



The EPSRC CDT in Quantum Computation and Quantum Communications (QC2) PhD programme will equip students with the necessary expertise and practical knowledge to fulfil the potential of this ground-breaking field. Students will undergo a comprehensive and rigorous cross-disciplinary training programme, collaboratively designed by a diverse team of UCL academics and our extensive network of partners.

Training and development

The fields of quantum computation and quantum communications are at a pivotal juncture, as the next decade will determine whether the long-anticipated technological advancements can be realised in practical, commercially-viable applications.

With a wide-ranging spectrum of research group activities at UCL, the programme is uniquely situated to offer comprehensive training across all levels of the quantum computation and quantum communications system stacks. This encompasses advanced algorithms and quantum error-correcting codes, the full range of qubit hardware platforms, quantum communications, quantum network architectures, and quantum simulation.

Graduate schemes

The four-year course consists of a six-month cohort-based intensive training programme (ITP) followed by a 42-month research project phase (RPP) leading to the PhD degree.

The ITP gives a broad overview of all the sub-topics within quantum computation and quantum communications, while the RPP allows specialisation and in-depth focus on a specific experimental or theoretical topic. There is however no hard boundary between the phases – there is research activity within the ITP, and cohort-based technical and transferable skills training in the RPP.

What we are looking for

We encourage applicants with outstanding academic records in a relevant technical disciplines (for example physics, computer science, engineering, mathematics, materials, chemistry) coupled with a broad outlook and a strong interest in quantum computation and/or quantum communications. We will be looking for applicants who will have achieved the equivalent of a good UK Master's (e.g. MSci, MPhys, MEng or MSc) degree by the time they join us. The programme will not accept applications from candidates who are only qualified to Bachelor's level. We strongly encourage applications from communities that are currently under-represented in quantum technologies research, including under-represented genders and ethnic groups.

Profile can be viewed at
physicsworldjobs.com

LOCATION
London, UK

MAIN AREAS OF RESEARCH
Quantum computation and quantum communication

DESIRED DEGREE DISCIPLINES/CLASS
Outstanding academic record in a relevant technical discipline (for example physics, computer science, engineering, mathematics, materials, chemistry)

PRE-REQUISITES
Eligible to study in the UK

HOW TO APPLY
Apply online at
www.ucl.ac.uk/quantum/study-here/quantum-doctoral-programmes/how-apply

CLOSING DATE
3 February 2026

CONTACT
University College London
Gower Street
London WC1E 6BT
UK
E-mail quantum-cdt-admissions@ucl.ac.uk
www.ucl.ac.uk/quantum

Zurich Instruments is a test and measurement company based in Zurich, Switzerland, with subsidiaries around the world. We develop, sell and support measurement instrumentation in key worldwide markets, either directly or with carefully selected partners.

Why work for us

You will work in a team of bright, creative and inspiring people. We all love technology, and work together with a positive and innovation-driven spirit. You will encounter a work environment with a lot of freedom to act, and space for creativity. We also believe that consistently good work performance requires a healthy work–life balance. This starts with a good working climate where we tackle daily challenges with persistence and a sense of humour.

Training and development

Our team members grow in their role, and are coached to successfully take more responsibility. Knowledge sharing and continuous learning across different functions is essential. We foster a culture of open and constructive feedback. Driven by our company values, everybody is encouraged to take leadership in order to achieve the best for our customers and for our company beyond functional and organizational boundaries.

What we are looking for

At Zurich Instruments we actively seek results-oriented self-starters who love to tackle challenges in a co-operative fashion. For our application scientist positions, they're people who want to transition from an academic path into a more commercial role, and for engineering positions they want to be part of a high-quality R&D team striving for the best-on-market measurement software and hardware solutions. You'll need to perceive daily variation as a positive stimulus for your own development and feel inspired working in a multicultural, hi-tech environment.

Profile can be viewed at
physicsworldjobs.com

LOCATIONS
Zurich, Switzerland; Shanghai, China; Boston, MA, US; Germany; Korea; Japan

NUMBER OF RESEARCHERS
175

CORE OFFERINGS
Quantum computing control system
Lock-in amplifier
Impedance analyser
Arbitrary waveform generator

POSITIONS RECENTLY RECRUITED FOR
Application scientist (quantum), application scientist (optics), technical sales, hardware engineer, software engineer, FPGA and firmware engineer

DESIRED DEGREE DISCIPLINES/CLASS
BSc, MSc or PhD, or equivalent, in physics, electrical engineering, or other technical fields, depending on the role

PRE-REQUISITES
US citizenship preferable for US-based roles

HOW TO APPLY
Apply online at **www.zhinst.com/company/career**

CLOSING DATE
All year round

CONTACT
Zurich Instruments
Technoparkstrasse 1
Zurich 8005
Switzerland
Tel +41 044 515 04 10
E-mail info@zhinst.com
www.zhinst.com

Engineering and materials

Catherine Phipps, who studied chemical physics at the University of Bristol in the UK, has worked as an engineer at Rolls-Royce for more than 30 years

What skills do you use every day in your job?

I originally joined Rolls-Royce to use my physics skills in an engineering environment and see them applied in the real world. My plan was to work in the materials department, thinking that would align with my degree. But after completing the graduate training scheme, I chose to join the mechanical-integrity team working on demonstrator engines. A few years later, I moved to Berlin to focus on small engines for civil aerospace before returning to Derby in the UK, where I'm now a mechanical integrity engineer working on large civil engines.

A large part of my job involves understanding how materials behave in extreme conditions, such as high temperature or extreme stress. I might, for example, run simulations to see how long a new component will last or if it will corrode.

I'll also design programmes to test how components behave when the engine runs in a particular way. The results of these tests are then fed back into the models to validate predictions and improve the simulations. Statistical analysis skills are vital too, as is the ability to make rapid judgements. Above all, I need to consider and understand any safety implications and consider what might happen if the component fails.

It's a team role, working alongside people from numerous other disciplines such as aerodynamics, fluid mechanics and materials, and everyone brings their own skills. We need to make sure our designs are cost-effective, meet weight targets, and can be manufactured consistently and to the right standard. It's immensely challenging work, which means I need to collaborate, communicate and – where acceptable – compromise.

Catherine Phipps

What do you like best and least about your job?

Best has to be the people. It's inspiring and motivating to work day in, day out in an international environment with talented, innovative and dedicated colleagues from varied backgrounds and with different life experiences. Sharing knowledge and coaching younger members of the team is also rewarding. Plus, seeing an aircraft take off and knowing you contributed to the engine design is an amazing feeling.

I did have a seven-year career break to have children, after which I was shocked at how much my colleagues had progressed. I felt in awe and inadequate. It was challenging to return, but everyone assured me the laws of physics hadn't changed and I soon got back up to speed. The hardest time for me, though, was working from home during COVID-19. Meetings continued online, but I missed the chance conversations with colleagues where we'd run ideas past each other and I'd learn useful information. I felt siloed and it was hard to share knowledge. The line between work and home was blurred and it was always tempting to leave the laptop on and "just finish something" after dinner.

I did have a seven-year career break to have children, after which I was shocked at how much my colleagues had progressed. I felt in awe and inadequate. It was challenging to return, but everyone assured me the laws of physics hadn't changed and I soon got back up to speed

What do you know today, that you wish you knew when you were starting out in your career?

First, don't think you always have to know the answer and don't be afraid to ask questions. You won't look stupid and you'll learn from the responses. When you start working, it's easy to think you should know everything, but I'm still learning and questioning all these years later. New ideas and perspectives are always valuable, so stay curious and keep wondering "Why?" – "What if?". You may unlock something new. Second, just because you start on one route, don't think you can't do something different. Your career will probably span several decades so when new opportunities arise, don't be afraid to take them.

Quantum optics

Raghavendra Srinivas is a research fellow in the Department of Physics and Balliol College at the University of Oxford, UK, and also works part-time for Oxford Ionics. His research focuses on using trapped ions for quantum information processing, quantum sensing and fundamental quantum optics. Srinivas was awarded Optica's 2024 Theodor W Hänsch Prize in Quantum Optics, which recognizes impactful early career researchers working on optics-enabled quantum technologies

What skills do you use every day in your job?

One of my favourite parts of being an atomic physicist is the variety. I get to work with lasers, vacuums, experimental control software, simulations, data analysis and physics theory.

As I'm transitioning to a more senior position, the skills I use have changed. Rather than doing most of the lab-based work myself, I now have a more supervisory role on some projects. I go to the lab when I can but it's certainly different. I'm also teaching a second-year quantum mechanics course, which requires its own skillset. I try to use my experience to impart more of an experimental flavour. The field is now in an exciting place where we can not only think about experiments with single quantum systems, but actually do them.

I also work part-time at a trapped-ion quantum computing company, Oxford Ionics, which has grown from about 20 to more than 60 people since I started in 2021. Being involved in a team with so many people has taught me a lot about the importance of project management. It's important to have the right structures in place to deliver complex projects with many moving parts. In addition, most of my company colleagues are also not physicists; it's important to be able to communicate with people across a range of disciplines.

What do you like best and least about your job?

Experimental physics is never boring, as experiments always find new and wonderful ways to break: 90–99% of the time something needs fixing, but when it works it's just magical.

I've been incredibly lucky to work with a fantastic group of people wherever I've been. Experimental physics cannot be done alone and I feel very privileged to work with colleagues who are passionate about what they do and have a wide variety of skills.

Stuart Bebb

It's important to be able to step back from the weeds of technical work and have an idea of the big-picture physics you're trying to solve

I also love the opportunities for outreach activities that my position affords me. Since I started at Oxford, I have led work placements as part of In2scienceUK and more recently helped start a week-long summer school for school students with the National Quantum Computing Centre. In many ways, I think promoting the idea that a career in quantum physics is accessible to anyone as long as they are willing to work hard is the most impactful work I can do.

I do dislike that as you spend longer in a field, more and more non-lab-based tasks creep into your calendar. I also find it difficult to switch between different tasks but that's the price to pay for being involved in multiple projects.

What do you know today, that you wish you knew when you were starting out in your career?

It's a difficult feeling for me to shake off even now, but when I started my career, I used to feel afraid to ask questions when I didn't know something. I think it's easy to fall into the trap of thinking it's your fault, or that others will think less of you. However, I believe it's better to see these instances as opportunities to learn rather than being embarrassed.

Scientifically, I think it's also really important to be able to take a step back from the weeds of technical work and have an idea of the big-picture physics you're trying to solve. I would have encouraged my past self to spend more time thinking deeply about physics, even beyond the field I was in. Just a couple of hours a week adds up over time without really taking away from other work.

One last thing I'd tell my past self is to think about boundaries and find a healthy work-life balance. It's easy to pour yourself completely into a project, but it's important to do this sustainably and avoid burnout. Other aspects of life are important too.

Photonics

Fatima Gunning is a physicist at the Tyndall National Institute, a research flagship of University College Cork (UCC), Ireland, where she is also head of graduate studies, and education and public engagement (EPE). Gunning is also a principal investigator at IPIC, the Research Ireland Centre for photonics and a fellow in the schools of physics and engineering and architecture at UCC

What skills do you use every day in your job?

I am fortunate to have several different roles, and problem-solving is a skill I use in each. As physicists, we're constantly solving problems in different ways, and, as researchers, we are always trying to question the unknown. To understand the physical world more, we need to be curious and willing to reformulate our questions when they are challenged.

In everyday work such as administration, research, teaching and mentoring, I also find that thinking outside the box is a winner when it comes to problem solving. I try not to just go along with whatever the team or the group is thinking. Instead, I try to consider different points of view. Researchers need to keep asking "Why?" Trying to understand a problem or challenge – listening and considering other views – is essential.

Another critical skill I use is communication. In my work, I need to be able to listen, speak and write a lot. It could be to convey why our research is important and why it should be funded. It could be to craft new policies, mediate conflict or share research findings clearly with colleagues, students, managers and members of the public. So communication is definitely key.

What do you like best and least about your job?

I graduated about 30 years ago and, during that time, the things I like best or least have never stayed the same. At the moment, the best part of my job is working with research students – not just at master's and PhD level, but final-year undergraduates who might be getting hands-on experience in a lab for the first time. There's great satisfaction and a sense of "job well done" whenever I demonstrate a concept they've known for several years but have never "seen" in action. When they shout "Ah, I get it!", it's a great feeling. It's also really rewarding to receive similar reactions from my education and public engagement work, such as when I visit primary and secondary schools.

Tyndall National Institute

Trying to understand a problem or challenge – listening and considering other views – is essential

At the moment, my least favourite part of my job is the lack of time. I'm not very good at time management, and I find it hard to say "no" to people in need, especially if I know how to help them. It's difficult to juggle work, mentoring, volunteering activities and home life. During the COVID-19 pandemic, I realized that taking time off to pursue a hobby is vital – not only for my wellbeing but also to give me clarity in decision making.

What do you know today, that you wish you knew when you were starting out in your career?

I wish I had realized the important of mentorship sooner. Throughout my career, I've had people who've supported me along the way. It might just have been a brief conversation in the corridor, help with a grant application or a serendipitous chat at a conference, although at other times it might have been through in-depth discussion of my work. I only started to regard the help as "mentorship" when I did a leadership course that included mentor/mentee training. Looking back, those encounters really boosted my confidence and helped me make rational choices.

Once you realize what mentors can do, you can plan to speak to people strategically. These conversations can help you make decisions and introduce you to new contacts. They can also help you understand what career paths are available – it's okay to take your time to explore career options or even to change direction. Students and young professionals should also engage with professional societies, such as the Institute of Physics. There are so many opportunities to meet people in your field and people are always happy to share their experiences. We need to come out of our "shy" shells and talk to people, no matter how senior and famous they are. That's certainly the message I'd have given myself 30 years ago.

Data acquisition and analysis

Daniel Hook is chief executive of Digital Science, a co-founder of the research-information management provider Symplectic, and of the Research on Research Institute. A theoretical physicist by training, he still does research in his spare time, with visiting positions at Imperial College London and Washington University in St Louis

What skills do you use every day in your job?

As the chief executive officer (CEO) of Digital Science – a company that improves the information and software tools for all stakeholders in the research ecosystem – I use a variety of skills every day. Many of these are exactly what most people would expect: managing people, reading financial statements – all the usual CEO activities. Thankfully for all concerned, I don't programme anymore. It's more than a decade since my code was in a production environment.

However, perhaps surprisingly to some, I do a lot of data analysis. Digital Science's core strength is our passion for understanding the research world as a route to offering better tools. For me, that means looking at what research is trending, understanding collaboration patterns, and gaining insight into how the scholarly record is changing. Not only are the data completely fascinating, but they are also the start of so many interesting discussions.

Alan Hyndman

The skills that I learned as a researcher are all applicable and helpful skills in any walk of life

What do you like best and least about your job?

Let's start with what I like least – which is travel, specifically the jet lag. While I do love spending time in different cultures, meeting people and seeing the beautiful nature and architecture in the places that I'm fortunate to visit, I find the jet lag to be very difficult and I'm constantly worried about my carbon footprint.

Last year I managed to do almost every trip in Europe by train and felt very good about it. But trips to Australia, New Zealand, Japan and the US still managed to make their way into my diary. This is somewhere I'm hoping that hybrid meetings find their feet soon.

As for what I like best about my job – that's easy. Not only do I work with the most talented, kindest and most passionate team, but we also serve those who are the positive agents of change in our world.

What do you know today, that you wish you knew when you were starting out in your career?

Like many people who started off working toward a research career, I defined my success very narrowly – specifically, in terms of being successful in a classically defined research setting. However, the skills that I learned as a researcher are all generally applicable and helpful skills in any walk of life.

They include having an entrepreneurial spirit, a willingness to try to solve a problem, the capacity to work hard and focus on that problem, and not give up when you don't find a solution with the first approach that you take. Success looks different for everyone and the problems that we contribute to solving, in any context, have the capacity to make people's lives better.

So, sometimes it's not good to "buy in" to what we're so often taught success should look like.

Condensed-matter physics

Katrin Erath-Dulitz is an assistant professor of physics at the University of Innsbruck, Austria. Her work to understand the fundamental aspects of chemical reactions involves using lasers at low temperatures to control the quantum states of the reactants. She was awarded a 2022 *Journal of Chemical Physics* Best Paper by an Emerging Investigator award for work published with her colleagues for which she was the principal investigator

What skills do you use every day in your job?

As a researcher, I rely on creative thinking both to design research projects and to solve problems in the laboratory. We have custom-built machines in the lab which often require some improvisation so that we can progress with our experiments quickly. As a group leader, I also need to work efficiently, keep everyone motivated and handle finances. I've always been very organized, but I have developed and refined other skills during my academic journey. When I started my research group a year ago, I was faced with an increasing workload and limited hours in the day, and learning to manage time effectively was a big challenge. My experience as a postdoc has also been valuable. For example, with limited financial resources, I quickly learned to prioritize cost-effective solutions. Similarly, I recognized that projects progress much faster in a team, so now I actively foster a collaborative environment within my group.

In my role as a university teacher, I need to make complex scientific ideas accessible to my students. I want to make them aware that the lecture content also has real-world applications, so I show them how the concepts I teach them are used in my laboratory. I also taught a course in which the students were asked to draft a proposal for an experiment at a large-scale laser facility. I wanted them to reflect on the lecture material and develop creative ideas for experiments.

What do you like best and least about your job?

The most rewarding aspect of my work is the opportunity to pursue projects that I am passionate about, ranging from understanding molecular interactions to constructing intricate scientific apparatuses for our research. I value

Anna Schlieben, University of Freiburg

Investing extra time in exploring content beyond that taught during university classes is crucial

the freedom to shape my daily schedule and to choose the projects that I want to engage in. There are also exciting aspects that I did not anticipate during my student days, such as the chance to attend international conferences and participate in scientific initiatives at large-scale research facilities all over Europe.

While my career is extremely exciting, frequent relocations over the past decade have made it difficult to establish roots and maintain friendships. Another challenge I have faced is the limited number of permanent academic positions – the uncertainty regarding my personal and professional future was something I found stressful. I feel very fortunate to have secured a position in Innsbruck, which has an exceptional working environment and a high quality of life, with many opportunities for outdoor activities.

What do you know today, that you wish you knew when you were starting out in your career?

Reflecting on my journey, I realize that I may have rushed through my studies. It is clear to me now that investing extra time in exploring content beyond that taught during university classes is crucial. Specifically, I regret not dedicating more time to studying quantum mechanics during my student years. I found myself needing to teach myself a considerable amount of it during my PhD.

Looking back, I wish I had trusted in myself more and started applying for scholarships as an undergraduate student. When I was asked to apply for scholarships for my PhD, I initially doubted my abilities, but with the help of my supervisor I took the chance, and I succeeded. My advice to other students struggling with imposter syndrome is to avoid comparing themselves to their peers and to find supportive mentors, as I did at this early stage.

Optical sensing

Andrew Weld is head of research and development at QLM Technologies, which develops optical sensors that can measure the wavelength-dependent absorption of a laser beam to map carbon dioxide and methane in the environment. Weld holds a PhD in optoelectronics from the University of Southampton in the UK

What skills do you use every day in your job?

In terms of physics, I manage most of our research and development projects, so I have to be able to give a technical overview of our work and explain how everything fits within the company's goals.

In a small start-up, those goals and priorities change rapidly. This can be based on feedback from customers, but when you're trying to get a new product to market there are always going to be fires to put out and technical issues to solve, whether that's hardware, software or component supply.

Also, while the technical aspects of my job are important, I need to have a good feel for time and budget, and be adaptable and flexible as circumstances change.

For example, we recently had an issue where some of our components came back from the supplier and weren't working correctly. In the long term, you can consider other suppliers or you can work with your current supplier to find a solution, but you also need to fix the immediate problem.

We found that we could change the way we were driving the component, which meant the performance wasn't optimal but we could still sell the products at a concession or use them for demonstrations. Managing those kinds of trade-offs is a big part of bringing a product to market.

The other important thing is people skills – I've found that just a little bit of diplomacy goes a long way. Working out how to handle people is quite a skill, and it's something that not everyone has.

What do you like best and least about your job?

My favourite aspect of working at QLM is that I believe we are on a worthwhile mission. We want our technology to be part of the solution to climate change, and that provides an extra bit of motivation.

Andrew Weld

Don't be afraid to push for personal development with your line managers. If that doesn't work, you might need to look elsewhere to put your career first

I also get to work with highly skilled scientists and engineers to develop our products and push the boundaries of our technology. It's also great to be part of the industry community and represent QLM at industry events.

The other thing I enjoy is problem-solving. This is still a fundamental part of my job, but in my current role I will often delegate rather than tackling the problem myself. This can be less satisfying but I have realized that sometimes it's more effective to use your experience to steer things in the right direction, rather than doing the frontline work.

QLM's lidar systems have a lot of components that need to function well together. So I'll often use my experience to guide junior staff, who will perform labour-intensive stages of assembling, programming and testing of our hardware.

What do you know today, that you wish you knew when you were starting out in your career?

You have to decide whether you're happy in your job. Sometimes the best thing to do is to recognize that if something's not working out for you, it's time to change.

It's easy to let yourself stagnate if you keep thinking "I'm sure this is going to change soon". That's something that we're trying very hard to not let happen at QLM but it's an issue I've seen elsewhere. We try to support our staff to develop new skills and to grow with the company, and we seek feedback from them to make sure they are happy in their work.

I look back and think I should have been a bit more ambitious, instead of staying in the lab doing the technical work. I would probably go back and tell myself: "You know what? You recognize that you've hit the limit of what you can achieve in that role". At QLM I enjoy being part of the senior leadership team, where I have responsibility both for developing the hardware and shaping the evolution of the company.

So my advice would be, don't be afraid to push for personal development with your line managers. If that doesn't work, you might need to look elsewhere to put your career first. You're probably going to be working for over 40 years, so make sure you enjoy what you do.

Policy and funding

Anne Pawsey is secretary general of the European Physical Society (EPS) in Mulhouse, France. After a PhD in soft-condensed-matter physics at the University of Edinburgh in the UK, she was a researcher on industry-linked projects and graduate school co-ordinator of the Scottish Universities Physics Alliance. She joined EPS in 2022 after three years at the University of Göttingen in Germany as teaching and e-learning coordinator of the Max Planck School Matter to Life

What skills do you use every day in your job?

Communication skills in all their forms are vital, whether it's giving a presentation, writing a news article, discussing matters with one of our boards, or working with the team at the secretariat of the European Physical Society (EPS) in Mulhouse.

I also use a lot of project-management skills. The EPS runs several international conferences, is part of European Union projects, and facilitates the work of our volunteer members to promote and support physics and physicists – so there are often a lot of plates to keep spinning at the same time.

I'm grateful for the broad knowledge of physics I acquired during my degree. My PhD was in soft-matter physics on the behaviour of colloids in liquid crystals, but I also occasionally find that specialist knowledge I picked up in areas of science beyond my thesis topic come in handy for understanding matters under discussion.

EPS/Gina Gunaratnam

I find that specialist knowledge I picked up in areas of science beyond my thesis topic come in handy for understanding matters under discussion

What do you like best and least about your job?

I really enjoy working with a huge community of physicists and getting to hear them talk with enthusiasm about their research. I particularly enjoy interacting with the EPS's Young Minds Sections and hearing about the outreach and engagement activities that they organize with EPS support.

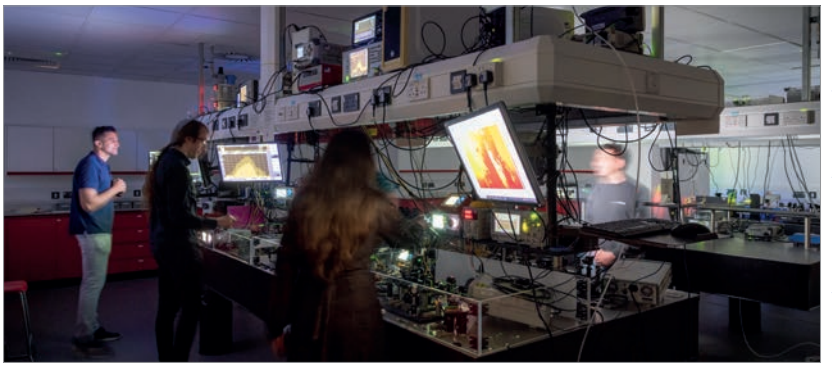
My job is also really varied, and no two days are the same. I might be travelling for an editorial meeting, working on administration in Mulhouse, or participating in a planning meeting for a conference – all in the same week. The downside is that I occasionally miss the focused quiet of a meticulous laboratory experiment and I rarely get the luxury of spending an uninterrupted block of time on something.

What do you know today, that you wish you knew when you were starting out in your career?

I wish I'd known how vital language skills would be. Of course, most science is formally communicated in English and as a native speaker I have an advantage. But everyday life around the world happens in each country's native language. The EPS is based in Mulhouse, France, very close to the Swiss and German borders, so I use French every day and have to converse in German at least once a week. I'm really grateful for the Erasmus year I spent in Grenoble during my degree for giving me a decent proficiency in French and the confidence to speak a foreign language.

Loughborough University
Emergent Photonics Research Centre

EMERGENT PHOTONICS RESEARCH CENTRE: LOUGHBOROUGH UNIVERSITY



Emergent Photonics Research Centre (EPicX) is a multi-million-pound facility advancing ultra-fast nonlinear photonics. We harness Photonics Complexity – a domain describing collective behaviours – to explore quantum and information technologies, AI, sensing, and imaging. We target socioeconomic impact, leveraging our core expertise in nonlinear optics.

Why study with us

We are a growing, passionate team, bringing state-of-the-art photonics to the heart of the Midlands to advance critical technologies – positioning, navigation, timing, AI, and sensing – within large international consortia. Our agenda includes terahertz waves, micro-lasers (microcombs), and AI-driven photonic control. We target creative, ground-breaking applications, including portable, accurate timing devices and unconventional imaging and neuromorphic computing. Backed by major funders, the Centre opened in June 2024, underscoring Loughborough University's commitment to world-leading fundamental research and innovation on a global scale.

Training and development

Our centre nurtures skilled experimentalists running high-energy, ultrafast lasers for fundamental interactions and developing ultracompact microchip-based lasers. Our work is supported by advanced metrology equipment, fabrication, and fibre-optic facilities. Robust theoretical and numerical expertise backs each experiment, spanning fundamental nonlinear optics and optimization control to professional programming of wave simulators and chip design. We provide training opportunities for early-career researchers, foster leadership through our international network, and encourage skill growth in every facet of photonic research.

Graduate schemes

EPicX routinely offers multiple PhD opportunities on our core projects. As part of Loughborough University's Department of Physics, we provide advanced photonics training through dedicated modules and postgraduate physics programmes. Our taught modules cover basic to advanced photonics principles – and blends rigorous theory with hands-on sessions and professional software training. Our Master's degrees in physics are a springboard, preparing graduates for impactful research careers in academia and industry.

What we are looking for

We routinely offer opportunities at various levels. For postdoctoral positions, candidates should have a proven track record of international involvement and a strong publication history. Demonstrated leadership potential, independence, and strong motivation are essential. We welcome atypical career tracks. For PhDs, we seek exceptional students from STEM backgrounds (physics, engineering, applied mathematics) intersecting with photonics. Our Centre supports successful fellows through competitive funding schemes. Independent fellows awarded personal grants currently make up a third of our postdoctoral researchers.

Profile can be viewed at
physicsworld.com/jobs

LOCATION
Loughborough, UK

NUMBER OF RESEARCHERS
24 research staff and students

MAIN AREAS OF RESEARCH
Ultrafast photonics, THz imaging, microcombs, quantum and photonic AI

POSITIONS RECENTLY RECRUITED FOR
Postdoctoral research associate in photonics; PhD studentship in photonics

DESIRED DEGREE DISCIPLINES/CLASS
Talented candidates in appropriate STEM subjects (physics, engineering, applied mathematics, advance mechanics) are welcome to apply for studentships and research positions within our team. For undergraduate degrees, generally AAB.

PRE-REQUISITES
Students: eligible to study in the UK
Staff: eligible to work in the UK

HOW TO APPLY
PhD studentships and PDRA vacancies are advertised, along with information on how to apply, at **www.lboro.ac.uk/research/emergent-photonics/vacancies**

CLOSING DATE
All year round

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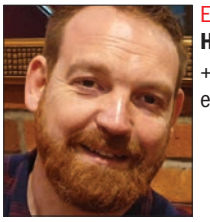

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Inside this publication from *Physics World* we highlight the career opportunities for those with a background in physics and related subjects.

This bumper-sized book includes helpful careers advice, real-life case studies, as well as an extensive employer directory powered by *Physics World Jobs*.

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