Australian Government
Chief Scientist

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IBM QUANTUM'S 'QUANTUM WOMEN INVITED TALKS'

The case for more women in quantum

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I want to start by acknowledging the Traditional Custodians of the land I'm speaking to you from today – the Ngunnawal people. I pay my respects to their Elders, past and present, and I extend that respect to all First Nations people joining us today.

What a brilliant idea to have women all over the world come together to tell their stories about their experiences with quantum. It's always exciting to hear how others have charted their journeys – I'm wonderfully inspired by how inventive we can all be. And we certainly need to be inventive to take on quantum!

Quantum is really extraordinary. I'm sure I'm preaching to the converted here, but the possibilities quantum offers are mind-boggling.

For me, it's been an incredibly stimulating field to work in: the problems are challenging, the commercial potential is enormous, and – to top it off – you're butting up against the very edges of human understanding at every moment.

That's the intellectual endeavour. But intellectual endeavour doesn't happen in a vacuum. We do science in a context.

Our journeys in quantum are all different. We all have our personal aspirations. We have our ambitions and hopes for what quantum will mean in our careers, in our communities and countries, and, more broadly – for humanity.

I've spent the past four decades in quantum, and even longer in physics. I found out early in my journey that the intellectual endeavour in physics and quantum is completely entangled with a cultural one (excuse the pun so early on). If it hadn't been for Heather Adamson – a senior lecturer at my alma mater – I would have never known that I could realise a career in what I was good at; in what I enjoyed most.

I've always been grateful to her for showing me that my options were more numerous than I knew at the time. She was the person who encouraged me to do Honours in physics – she said she was sure I'd get a scholarship and First Class; that I would be a great scientist. I was on track to be a schoolteacher before I bumped into her in the carpark that evening, but after that conversation, I enrolled in Honours in physics and never looked back.

I was grateful that she thought to reach out – that she didn't take for granted that I would know I could make a career out of research and discovery in science – in physics. There were so few women in the field. I was one of only two women in my undergraduate classes and the only woman in my postgraduate studies. It was hard to imagine that I could have a place there. Never underestimate the power of encouragement!

Today I want to speak to you all about quantum and my wonderful time in the field. I want to encourage women to enter it and leave their mark on it. But I don't want to gloss over the difficulties. You should go in with your eyes open. You should also know that there is work in train to make the systems better.

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I went into my education and my career in physics with some sense of the barriers that I would come up against, but I have to say that I didn't appreciate the full scope. The science completely absorbed me – there was a challenge at every turn. I was part of so much totally new, ambitious work.

I always loved going into the lab. The feeling of creating something is so special – the feeling of working in a team on a big idea, something that fits into a broader system, something that might genuinely solve a problem. There's nothing quite like it.

I remember during my postdoc we were working to make nanoscale devices for detecting small magnetic fields. We blew up the device so many times trying to take our measurements – it's very easy to blow your device when you're working at the nanoscale! But we finally got there. We succeeded in making that single-grain boundary, and I couldn't believe it. We'd been working at the atomic level, and we had a device that did what we wanted. It blew me away.

That device is now the standard structure for making sensitive magnetic field measurements using high-temperature superconductors. It was incredible to be part of that – to know I'd made an impact.

Physics and quantum are fantastic fields to be part of if you want to make an impact. Of course, it isn't all successes, especially when the ambitions are big. There's

always another problem, and there's always more work to do. But when you have an audacious goal, you have to take it one step at a time.

And of course, there were challenges because I was a woman. I was doing that postdoc in the 1980s. Too often, I was the only woman in the team – the only woman in the room. I was fielding marriage proposals from researchers I barely knew while doing that work. No-one should have to put up with that.

My approach for much of my early time in physics was to do everything I could to fit into an environment that was often not the right shape for me. When I came up against a barrier, I would find a way to scale it. When there was no childcare centre at CSIRO in Lindfield – where I did my postdoc and where I worked afterwards – a team of us got together to build a case for it. We surveyed, lobbied and negotiated. And we got it. It was actually the first one in the region. I was treasurer for that childcare centre for seven years.

You can make impact from the position you're in. But with time, I learnt that what we also need is nationwide, structural change to encourage women into these fields and to support them to stay when they enter.

When I was appointed Australia's Chief Scientist in 2021, I was asked to give an address to the National Press Club – a terrifying rite of passage! I was asked a question after the talk about women in STEM, and I explained how I'd learned to navigate the system. After that, a group of women from universities in Western Australia took me to task on that answer. Speaking with them changed the way I speak about 'women in STEM' today. I used to talk about how to adapt to the system. Now I know that it's the system that needs to change – not the women.

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It will come as no surprise to you that women are seriously underrepresented in STEM education and careers in Australia, especially in physics, IT and engineering – the feeders for quantum science.

It's essential in Australia, as it is elsewhere, that we grow the STEM workforce quicky – there's huge demand, not only in quantum, but in the other sectors that will drive the industry over the next two decades – clean energy, biotechnology, personalised medicine, AI, robotics. Quantum technologies will impact almost every

part of our lives – they will give us new ways of monitoring health at the cellular level, new therapies, new materials for the energy transition, navigation without GPS, the ability to create entirely new molecules. They will allow us to ask questions and solve problems we haven't had the tools to tackle before. The range of possibilities is astounding.

To make our quantum leaps, we need people trained in quantum physics, of course, but we also need people with broader science and software savvy; we need people in electrical engineering, data science, maths, precision manufacturing and nanofabrication. These are all part of quantum.

And women are underrepresented in quantum. Women make up only 12.5% of full-time quantum physicists at Australian universities.

It's essential that we have gender equity in our future quantum workforce. It's essential that we have socioeconomic, age, cultural and neuro-diversity. The more diverse the perspectives and experiences of our future workforce, the better off we'll be. And the more people working on a problem – the sooner we'll solve it!

I want to tell you the story of Henrietta Leavitt. She was an astronomer at the Harvard College Observatory in the early 1900s. She was tasked with cataloguing photographic plates of stars captured as part of the College's collection. Leavitt studied variable stars – they're called 'variable' stars because their brightness changes over time. This was no small task – each plate Leavitt studied had thousands of stars on it, and she was looking for differences in brightness of these stars on different nights.

She figured out that there was a relationship between the inherent brightness of a type of variable star and the time it took to brighten and dim. This relationship eventually allowed us to work out the distances of stars in nearby galaxies. It was a huge breakthrough – a leap forwards for astronomy and for our understanding of how we fit into our celestial neighbourhood; how we fit into our universe.

But Leavitt, because she was a woman, wasn't allowed to work in the observatory or on the theoretical work – she couldn't follow up on her findings or look for answers to her questions. The answers would have to wait until a man got hold of her work, got into the observatory, and started his own investigations. Who knows what else she

might have discovered? Who knows how much quicker we might have made that leap and others that followed from it?

This is a story that's a century old, and we've made lots of cultural changes since then. But it's also a story of barriers getting in the way of potential and possibility. And that doesn't sound like too different a story from the one where so many women are still missing from physics and quantum.

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The good news is that there is work being done right now to build a STEM workforce – and a quantum workforce – that attracts women and supports them to stay.

One of the five pillars of Australia's National Quantum Strategy, released earlier this year, is to build a skilled and growing quantum workforce.

Embedded in the Strategy are actions to promote STEM in schools, universities, and vocational education institutes to get as many students excited about STEM as possible. And there is an explicit commitment in the Strategy to create initiatives that lift the participation of women in STEM. There is state, territory and federal support, and there's a commitment to work across sectors – academia, industry, and government.

I have 2 pieces of work underway in this area. My Office has commissioned an in-depth look at STEM career pathways – that means mobility inside and across STEM sectors, and it means retention. This research looks at how to make STEM careers accessible to everyone.

Career mobility is a real issue for women in STEM – so is retaining them when they enter the workforce. It's more likely for women to be on fixed-term contracts, and it's hard for them to come back to their STEM careers when they take breaks – for example, to care for children. This is especially an issue for women in the STEM research workforce.

The second piece of work commissioned from my office is about research metrics – how success is measured in the research sector. My Office will be releasing this report very soon. The ways we currently measure success in the research sector put several groups, including women, at a disadvantage. I'm sure you've heard of

the phrase ‘publish or perish’. This mindset really undermines progression for anyone who takes a break in their career. We shouldn’t be penalising people for taking breaks to care for their families, and we shouldn’t be penalising people who pivot during their careers to gain new skills in another sector.

These reports are going to give us some specific places to focus on to change the systems that disadvantage women.

When we take this goal to heart and listen, we get programs that work.

Earlier this year, I was invited to launch two exciting initiatives nationally – the Einstein-First and Quantum Girls programs. Einstein-First started in Western Australia – it introduces children to the science that underpins our modern technologies. The program is now being offered in schools all over Australia.

Einstein-First also inspired the Quantum Girls program, which has set a goal to train 200 female teachers in quantum, who will go on to teach girls in their early teens the quantum concepts that will drive the quantum revolution here and all over the world.

There is also the Curious Minds program. I’ve been involved with this program since its inception, and I’ve seen the incredible work it does to show girls from all backgrounds the STEM pathways open to them. In 2015, the program had 52 girls enrolled, and in the latest call-out there were 600 expressions of interest for 110 places! The girls’ interest in pursuing STEM subjects at university increased after the program – including in physics and IT. They started to realise what was possible.

So the challenge is big, yes, but there is work going on right now to change the system.

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If you set your sights on a career in quantum, you will never be short of opportunities. In Australia, quantum technologies are expected to generate 16,000 new jobs by 2040.

I’ve been lucky enough to make it my life’s work. There’s nothing like being part of a team of researchers, technicians, and entrepreneurs – a truly global team – trying to make the world better. The science community I have been part of here in Australia

and internationally is a curious, dedicated, and supportive one. There is a true sense of shared purpose. You will be part of that.

Research, design, innovation – it's all a roller coaster, like my PhD supervisor used to say. It takes resilience. And belonging to this community is what helps you weather the tough times. My colleagues are where I've found endless inspiration – there's no one who makes superconducting devices like Jeina Lazar! There's no one who creates housing and dewars like Rex Binks!

I want to see us realise our ambitions in physics and quantum – the scientific and the structural.

And I'm optimistic that we'll get our ducks in a row. I'm optimistic because of the incredible developments I've seen and been part of in physics and quantum – because of incredible women leading the quantum revolution.

This week, Professor Michelle Simmons was awarded the top science prize in Australia for her work in quantum. She founded Australia's first quantum company – Silicon Quantum Computing. It's the only place in the world where electronic devices are built with atomic precision. She originated a field – atomic electronics. She's director of the Australian Research Council Centre of Excellence for Quantum Computation and Communication Technology. And she's set her sights on building the world's first error-corrected, silicon-based quantum computer.

If we back diverse, inclusive STEM and quantum ecosystems, just imagine the potential we'll realise. We need to continue to change the shape of these fields so that everyone can come to STEM as themselves – and know that they can do this too.