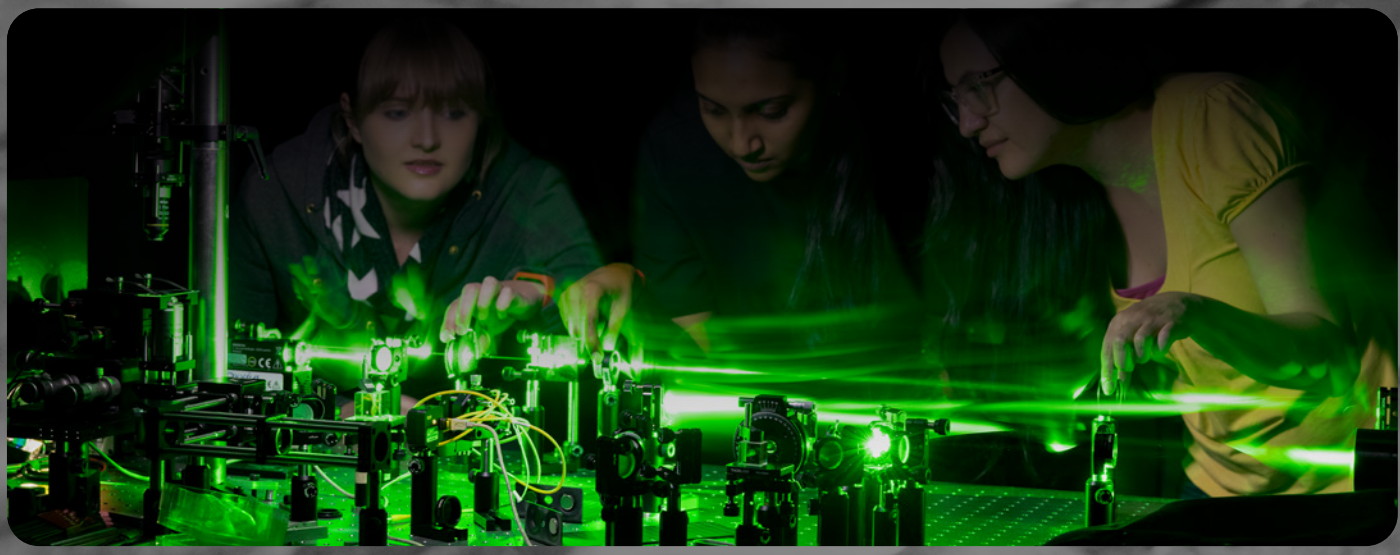
The light fantastic

A quantum approach to light, physics, communication and computing, with Professor Andrew Forbes.

Tiana Cline Karolina Komendera



"In the modern world, we don't only want our internet to be fast, we want it to be secure. And we know that as soon as a quantum computer works properly – and they're not very far away from that – it will break all man-made algorithms," says Professor Andrew Forbes, a distinguished professor at the University of the Witwatersrand (Wits), who started the Structured Light Laboratory in the School of Physics back in 2015.

The application of quantum technologies extends far beyond quantum computing. Forbes works with quantum imaging and engineering and believes quantum health could be the next big thing. Most quantum programmes today are national, with many being driven by technology companies like IBM, D-Wave Systems and Google, not universities. "They're national strategies because quantum is not just fun research. It really does matter; it's not just a nice-to-have anymore, it's a have-to-have. If you had asked me 10 years ago, 'would a quantum computer be able to break codes?', I would have said not in my lifetime. If all of our algorithms can be broken, what can you do to make them secure? The only thing you can do is to use quantum communication. We use the laws of physics to make data more secure so that someone would have to break the laws of nature to break the code."

Quantum communication

In the Structured Light Laboratory, Forbes and his team manipulate light. They tailor it, cut it and customise it for a range of unique applications. "How quantum comes into it, is that when we do the structuring of lights, there are three levels: we design and build lasers and the laser itself gives off light. Then we do it outside the laser – here we buy a commercial, off-the-shelf laser and we do some customising of its light for whatever we want to do with it. And the third level is quantum," explains Forbes, who is also the director of Wits' Quantum Initiative (WitsQ) and co-author of *South Africa's Quantum Roadmap* (which was approved by the Department of Science and Technology in March 2021).

He adds that in the quantum world, there are two ways to get light. The one path is going down to a single particle of light, and then the light can be built up from particles, called photons. "The second way to get there is a crazy, spooky process called entanglement. The notion is that you can

> **"Within a decade, all financial sectors, worldwide, will have to be using some quantum technology in the workplace."**
>
> **Professor Andrew Forbes,** Wits

put these particles as far away as you want – on opposite ends of the universe – and if you do something to the one, immediately the other one feels the effects."

In the normal world, it's not possible because signal has to travel a long way, but with quantum, this doesn't have to be the case. In a 'quantum world', encryption is based on the laws of physics, it's not man-made. "With quantum, what happens is that information gets lost if somebody tries to break the code. They can't get it, but unfortunately neither can you. It can never be broken so it's fundamentally secure," says Forbes. "The way I see it, within a decade, all financial sectors, worldwide, will have to be using some quantum technology in the workplace. And if they're not, they'll be running at a huge risk."

While manipulating patterns of lights and high dimensions may sound obscure, it has a big commercial drive and the progress being made with quantum communication is really fast. "Think of it like a coin. On the bad side of a coin is the quantum computer. It can break all of your banking codes – the financial sector will come to a grinding halt. It's the death knell for all of that. But fortunately, on the flip side of that coin is the solution and the solution is also quantum – quantum communication," says Forbes. "The more patterns you have, the more information you can put into that particle of light and so the more information you can send between two people. So obviously we'd like to send as much as possible, but have it secure."