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QUANTUM | BLOG

Quantum science and technology: highlights of 2025

28 Dec 2025 Margaret Harris

(Courtesy: iStock/Jian Fan)

There's only a few days left in the International Year of Quantum Science and Technology, but we're still finding plenty to celebrate here at *Physics World* HQ thanks to a long list of groundbreaking work by quantum physicists in 2025. Here are a few of our favourite stories from the past 12 months.

Observing negative time in atom-photon interactions

By this point in 2025, "negative time" may sound like the answer to the question "How long have I got left to buy holiday presents for my loved ones?" Earlier in the year, though, physicists led by experimentalist Aephraim Steinberg of the University of Toronto, Canada and theorist Howard Wiseman of Griffith University in Australia showed that the concept can also describe the average amount of time a photon spends in an excited atomic state. While experts have cautioned against interpreting "negative time" too literally – we aren't in time machine territory here – it does seem like there's something interesting going on in this system of ultracold rubidium atoms.

Creating an operating system for quantum networks

It is a truth universally acknowledged that any sufficiently advanced technology must be in want of a simple system to operate it. In April, the quantum world passed this milestone thanks to Stephanie Wehner and colleagues at Delft University of Technology in the Netherlands. Their operating system is called QNodeOS, and they developed it with the aim of improving access to quantum computing for the 99.99999% percent of people who aren't (and mostly don't need to be) intimately familiar with how quantum information processors work. Another advantage of QNodeOS is that it makes it easier for classical and quantum machines (and quantum devices built with different qbit architectures) to communicate with each other.

Pushing the boundary between the quantum and classical worlds

How big does an object have to be before it stops being quantum and starts behaving like the billiard-ball-like solids familiar from introductory classical mechanics courses? It's a question that featured in our annual "Breakthrough of the Year" back in 2021, when two independent teams demonstrated quantum entanglement in pairs of 10-micron drumheads, and we're returning to it this year in a different system: levitated nanoparticles around 100 nm in diameter.

In one boundary-pushing experiment, Massimiliano Rossi and colleagues at ETH Zurich, Switzerland and the Institute of Photonic Sciences in Barcelona, Spain cooled silica nanoparticles enough to extend their wave-like behaviour to 73 pm. In another study, Kiyotaka Aikawa and colleagues at the University of Tokyo, Japan performed the first quantum mechanical squeezing on a nanoparticle, narrowing its velocity distribution at the expense of its momentum distribution. We may not know exactly where the quantum-classical boundary is yet, but the list of quantum behaviours we've observed in usually-not-quantum objects keeps getting longer.

Using a quantum computer to generate quantum random numbers

What's the best way to generate random numbers? In part, the answer depends on how random those numbers really need to be. For many applications, the pseudorandom numbers generated by classical computers, or the random-but-with-systematic-biases numbers found in, say, radio static, are good enough. But if you really, really need those numbers to be random, you need a quantum source – and thanks to work published this year by Scott Aaronson, Shi-Han Hung, Marco Pistoia and colleagues, that quantum source can now be a quantum computer. Which is a neat way of tying things together, don't you think?

Giving Schrödinger's cats a nuclear option

Quantum cats Left to right are UNSW researchers Benjamin Wilhelm, Xi Yu, Andrea Morello, Danielle Holmes. (Courtesy: UNSW Sydney)

Finally, we would be remiss not to mention the work of Andrea Morello and colleagues at the University of New South Wales, Australia. This year, they became the first to create quantum superpositions known as a Schrödinger's cat states in a heavy atom, antimony, that has a large nuclear spin. They also created what is certainly the year's best scientific team photo, posing with cats on their laps and deadpan expressions more usually associated with too-cool-for-school indie musicians.

So congratulations to them, and to all the other teams in this list, for setting the bar high in a year that offered plenty for the quantum community to celebrate. We hope you enjoyed the International Year of Quantum Science and Technology, and we look forward to many

more exciting discoveries in 2026.

Margaret Harris is an online editor of *Physics World*

< Back to Quantum | ⊚

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