UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME

Networked quantum computing

A UK collaboration is using light to link small quantum processors, an ion-based approach that could lead to large, powerful quantum computers.

- This network structure enables scale-up, bringing quantum computing closer
- Technology exploits UK expertise in photonics
- Group has achieved world records for information quality and memory time

Quantum computers have huge promise. Instead of classical bits of information (0 or 1) they handle quantum bits, or qubits (a combination of 0 and 1 in any proportion). In theory this makes them much faster than any classical computer for some types of calculation. They could transform machine learning and solve previously impossible optimisation problems in engineering and planning.

In practice, when you try to cram a lot of qubits together in a single processor, it becomes almost impossible to control them all. This is true of many different approaches, including qubits stored in superconducting circuits, clouds of cold atoms, and the spins of atomic nuclei.

The Networked Quantum Information Technologies (NQIT) Hub is taking a different approach. A team at the University of Oxford, collaborating with other universities and more than 30 companies, has developed small, modular processors. Each holds five qubits, with each qubit stored in the state of trapped calcium and strontium ions. The ions emit single photons that can carry quantum information to other processors, linking them together so they behave as one larger machine.

The difficult part is making that connection reliable, but in 2018 the NQIT team successfully achieved this – demonstrating network connectivity between nodes for the first time. Meanwhile, the team have refined their processors to run with an exceptionally low error rate, with the highest quality logic gates of any quantum computing architecture.

The project is funded by EPSRC as part of the National Quantum Technology Programme (NQTP). “The programme has helped us to completely transform the level of equipment and increase the size of the group,” says NQIT team member Joe Goodwin at the University of Oxford.. “Funding like this is essential if the UK is to remain competitive in the race to build a quantum computer.” The programme has already enabled close collaboration with commercial companies to develop technologies including optical switches and advanced laser systems.

By the end of 2019, the aim is to demonstrate some simple quantum algorithms across the network. Then, during phase 2 of the NQPT, the collaboration will increase the size of the machine, with nodes that are cheaper and more reliable, laying all the groundwork for a commercially valuable quantum computer.

Industrial collaborators include:

- MSquared Lasers
- Gooch & Housego
- m-Labs
- Technosystems
- Warsaw Institute of Technology

For more information, visit ukqtp.epsrc.ac.uk or contact quantumtechnologies@epsrc.ukri.org

The UK National Quantum Technologies Programme aims to ensure the successful transition of quantum technologies from laboratory to industry. The programme is delivered by EPSRC, Innovate UK, BEIS, NPL, GCHQ, Dstl and KTN.

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