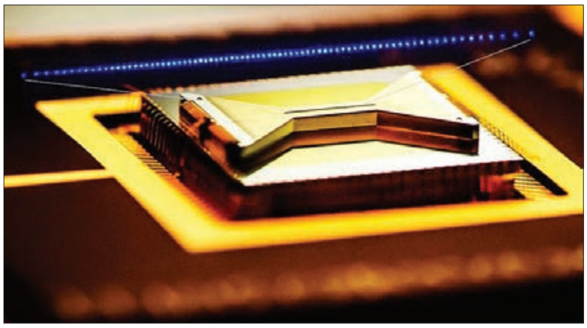
Innovation

First commercial ion-based quantum computer built

The first commercial quantum computer using trapped ions for quantum bits (qubits) has been launched by IonQ, a spin-out company from the University of Maryland in the US. Developed by Christopher Monroe – IonQ's co-founder and chief executive – the device is unlike other commercial systems, which use qubits made from superconducting circuits.

Ion-trap computers work by holding the ions in a geometrical array, with IonQ using a simple linear arrangement (right). Laser beams encode and read out information to and from individual ions by causing transitions between an ion's electronic states. During a computation, the ions "feel" one another's state via electrostatic interactions. The IonQ device uses ytterbium ions that, unlike superconducting qubits, do not need to be cooled to near absolute zero and so do not require bulky cryogenic equipment.

The IonQ device can host 160 ion qubits, exceeding the 50-qubit devices reported by IBM and Google, although the latter is said to be preparing a 70-qubit machine. The company has performed simple quantum operations on a string of 79 qubits and full quantum computations on 11 qubits.


Christopher Monroe

Quantum business Montage of a photo of the chip containing the trapped ions and an image of the ions in a 1D array.

But the power of a quantum computer depends not only on the number of qubits, but also on how well each performs, which is where ion-trap devices might have an advantage. Ensuring that every qubit is identical, for example, is easier with ions because superconducting circuits are much more complicated to make. Moreover, the ions are less error-prone, showing an excellent "gate fidelity" – the probability that the gate produces the quantum state it is supposed to – of more than 99%.

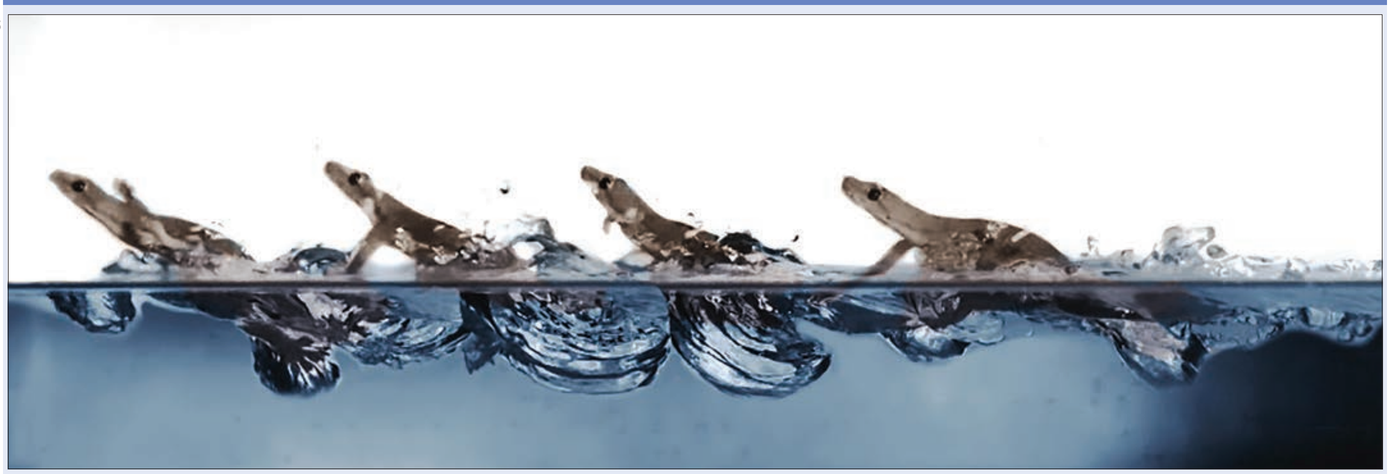
"A fidelity of 99% roughly means that you can do about 100 operations before the quantum state becomes gibberish," says Monroe. This means that IonQ's quantum computer might be able to handle "deeper", more complex algorithms with more operations.

The IonQ device has already been used to calculate the binding energies of simple molecules. In principle, quantum computers should be able to do these calculations exactly, rather than needing the approximations that must traditionally be used for any atom or molecule with more than one electron. The IonQ machine was used to do this calculation for a water molecule – a more complicated case than the lithium and beryllium hydrides studied using IBM's quantum computer.

However, unlike the IBM Q quantum computer, the IonQ device is not yet available to all-comers. Monroe explains that they are still a small firm and so will work with a few users who can help design and improve the current and future systems. Ultimately, however, the company aims to make the computer more widely accessible via a cloud server.

Philip Ball

Revealed: how geckos sprint on water


Current Biology

For some animals, walking on water isn't a trick of the eye. Small insects like the pondskater stay afloat even when stationary thanks to water's high surface tension, while basilisk lizards and other large animals avoid sinking by slapping the water with their legs and propelling forward with their tails. Using high-speed cameras, Jasmine Nirody from the University of Oxford and her colleagues have now discovered how geckos – lying between these size extremes – sprint over the surface. These lizards have a "trotting" gait that creates air cavities below the surface, letting them keep their heads and upper bodies above water as they run. Geckos also laterally undulate their submerged tails and lower bodies to generate forward thrust. Adding soap halves the lizards' speed, implying that surface tension is vital to their motion too (*Current Biology* **28** 4046).