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# 'Electron-spin' trick boosts quantum computing

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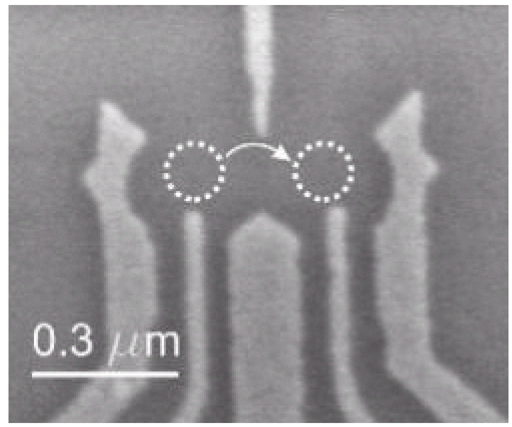
A new silicon chip capable of manipulating the spin of a single electron could ultimately allow futuristic quantum computers to be built using conventional electronic technology, researchers say.




Enlarge image

An electron microscope shows the structure of the circuit (Image: Frank Koppens)

A quantum bit, or "qubit", is analogous the bits used in conventional computers. But, instead of simply switching between two states, representing "0" and "1", quantum physics permits a qubit to exist in more than one state simultaneously, until its state is measured.

This means quantum computers can essentially perform multiple calculations at once, giving them the potential to be exponentially more powerful than conventional computers.



Researchers have previously developed rudimentary quantum computers by exploiting exotic phenomena to generate qubits. Two of the most sophisticated methods involve using ions trapped in magnetic fields and electrons in superconducting circuits. However, both approaches are far more complicated than making the chips that power conventional computers.

## 'Breakthrough experiment'

Researchers have also created qubits from the "up" or "down" spin-states of electrons on quantum dots. But they lacked the ability to control the state of a single electron well enough to perform calculations using them. A team led by Lieven Vandersypen at Delft University of Technology in the Netherlands has now created a device that can manipulate a single electron using conventional microchip fabrication technology.

"This is a breakthrough experiment," says Guido Burkard, a physicist at the University of Basel in Switzerland, who was not involved in the research. "A major benefit of making a qubit using this method is that they are built upon existing semiconductor technology." This should make the qubits easier to scale up into larger systems, he adds.

The Dutch team's device was made using conventional microchip lithography. It consists of two electrodes that apply voltage across two semiconducting quantum dots - pieces of gallium arsenide each 100 nanometres across - to form a simple circuit.

The voltage causes electrons to hop between the dots. Each dot can accommodate two electrons but only if they have opposite spin.

**Joined dots**

This causes two electrons, with matching spin states, to become jammed - one on each dot. The researchers then isolated the dots from the circuit and used a magnetic field to alter the spin of the electron on the first dot. Once plugged back into the circuit, current will only flow if the first electron has been switched to a different spin-state to the second, proving it has been switched.

Burkard says electron-spin qubits could now rapidly catch up with more established methods of quantum computing. "I see no roadblocks to moving towards the first implementation of small quantum algorithms using electron-spin qubits," he says.

Journal reference: *Nature* (vol.442, p.766)

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