Controlling single electrons for novel devices

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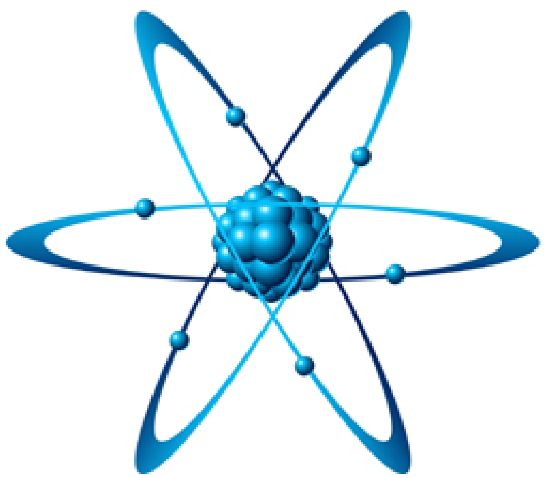

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European scientists conducted groundbreaking single-electron experiments with exciting results for the field of nanoelectronics and quantum computing.

Quantum computers are based on the exploitation of qubits, the quantum analogue of the classic bit. Whereas the classical bit can exist as either a 0 or a 1, qubits can exist in more than one state simultaneously and, in fact, in an infinite number of superpositions of two states at any one time.

The qubit stores information based on the spin of an electron (sometimes referred to as 'spin up' and 'spin down'), a property related to the orientation of its intrinsic angular momentum. Controlling and manipulating electron spin is thus the basis of tomorrow's quantum computing devices.

Excellent control of single electron spin has been achieved in small chunks of semiconductor material (quantum dots). However, the coherent transport of electron spin from one place to another and thus the possibility of non-local interactions between qubits is the missing piece of the puzzle.

European scientists sought to provide the missing piece by demonstrating coherent transfer between two quantum dots with EU funding of the 'Coherent transport of a single electron spin in semiconducting nanostructures' (Spintransfer) project.

Having successfully developed the techniques for nanofabrication of dot structures and the technology to detect electron state, the scientists demonstrated efficient transfer of a single electron from one quantum dot to another distant to it.

In addition, the transfer occurred on a nanosecond timescale critically important to use of the technology in fast calculations required by quantum computing.

Among the most important results, the Spintransfer team demonstrated the ability to separate two electrons in a singlet state (paired with opposite spins) to potentially produce a distant pair of entangled electrons. Entanglement means that the state of one induces a correlated state in the other, although they may separate from each other and no longer be paired.

The findings were published in the prestigious journal *Nature*.

Spintransfer's ground-breaking experiments and scientific advances open the door to exciting new routes of investigation of coherent single electron transport. They have brought the scientific and consumer communities one step closer to advanced spintronics devices exploiting electron spin for novel functionalities.

Provided by CORDIS

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