NIST Demonstrates Better Memory with Quantum Computer Bits

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Physicists at the National Institute of Standards and Technology (NIST) have used charged atoms (ions) to demonstrate a quantum physics version of computer memory lasting longer than 10 seconds—more than 100,000 times longer than in previous experiments on the same ions.

The advance improves prospects for making practical, reliable quantum computers (which make use of the properties of quantum systems rather than transistors for performing calculations or storing information). Quantum computers, if they can be built, could break today's best encryption systems, accelerate database searching, develop novel products such as fraud-proof digital signatures or simulate complex biological systems to help design new drugs.

As described in the Aug. 5, 2005, issue of Physical Review Letters,* NIST scientists stored information in single beryllium ions for longer periods of time by using a different pair of the ions' internal energy levels to represent 1 and 0 than was used in the group's previous quantum computing experiments. This new set of quantum states is unaffected by slight variations in magnetic fields, which previously caused memory losses in ions stored in electromagnetic traps.

Quantum memory must be able to store "superpositions," an unusual property of quantum physics in which a quantum bit (qubit) such as an ion represents both 0 and 1 at the same time. The new approach enables qubits to maintain superpositions over 1 million times longer than might be needed to carry out the information processing steps in a future

quantum computer. The advance is, therefore, an important step toward the goal of designing a “fault tolerant” quantum computer because it significantly reduces the computing resources needed to correct memory errors.

In related experiments also described in the paper, NIST scientists demonstrated that pairs of “entangled” ions can retain their quantum states for up to about 7 seconds. Entanglement is another unusual property of quantum physics that correlates the behavior of physically separated ions. Superposition and entanglement are the two key properties expected to give quantum computers great power.

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