Researchers develop prototype of advanced quantum memory

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Employees of Kazan Federal University and Kazan Quantum Center of Kazan National Research Technical University demonstrated an original layout of a prototype of multiresonator broadband quantum-memory interface.

Professor Sergey Moiseev, Director of Kazan Quantum Center, explains, "The scheme of multiresonator microwave quantum memory allowed for reaching 16.3 percent of quantum efficiency at room temperature, which was significantly better than other recent results in the world for microwave quantum memory in electronic ensembles at helium temperatures. We also showed that quantum efficiency of such memory can be over 99 percent at sufficiently low temperatures used in quantum computer schemes on superconducting qubits."

This work of Kazan physicists can help create universal memory solutions for quantum computers on superconducting qubits, which is one of the most important tasks in this field today.

Instead of binary bits, quantum computers operate via qubits, which can simultaneously contain a superstate of zero and one simultaneously due to the laws of quantum physics. A quantum computer with a sufficient number of operational qubits can quickly tackle calculations for which binary logic computers would require hundreds of years.

In March 2018, Russian scientists built a computing system of two superconducting qubits that serves as a basis for quantum computers and

data encryption systems. In the labs headed by Mikhail Lukin (Harvard University) and John Martinis (Google), the first prototypes of 500 qubit computers have been assembled. They are expected to showcase advantages that quantum computing has over classic binary computing.

Co-author Oleg Sherstyukov says, "The achievements of recent years in superconducting qubits have not only been linked with the increase in the number of interacting qubits, but also with a significant lengthening of a superconducting qubit's lifetime—to 100 microseconds. However, it's impossible to increase this time further because of fundamental laws of physics. In that regard, the problem of creating multi-qubit microwave quantum memory with a prolonged lifetime has become very pertinent."

Russian and overseas scientists have been working on this topic for several years now. Professor Moiseev adds that the most promising achievements have been based on the scheme of photon echo on an ensemble of atoms, the one that was proposed and explained by Kazanites. In 2010, employees of Kazan Quantum Center proved that photon echo quantum memory can be created in an optical resonator, which paved the way to multi-qubit integral schemes of quantum memory and its inaugural implementation in microwave frequencies.

More information: S. A. Moiseev et al, Broadband multiresonator quantum memory-interface, *Scientific Reports* (2018). DOI: 10.1038/s41598-018-21941-6

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