From macroscopic quantum coherence to superconducting quantum computing

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Superconductivity was discovered in 1911, before the theory of quantum mechanics was formulated in 1925. The physics of superconducting qubits was conceived in 1980, before quantum information science was widely acknowledged in the 1990s. From history, we learn how difficult it is to predict the progress of science and technology. Breakthroughs often occur at a level beyond our imagination.

Now, a quarter century after the first demonstration of a superconducting qubit, superconducting quantum computers exist to our surprise (or not?). They are still small-scale, error-prone, and not yet widely outperforming classical computers. There remain, not surprisingly, many challenges to be overcome before realizing a large-scale, fault-tolerant superconducting quantum computer. Control and readout of qubits must be fast and high-fidelity, and the overall scalability must be ensured from quantum processor units to packaging, wiring, cryogenics, control electronics, error correction, and software. New ideas are emerging, and technologies are evolving.

Figures

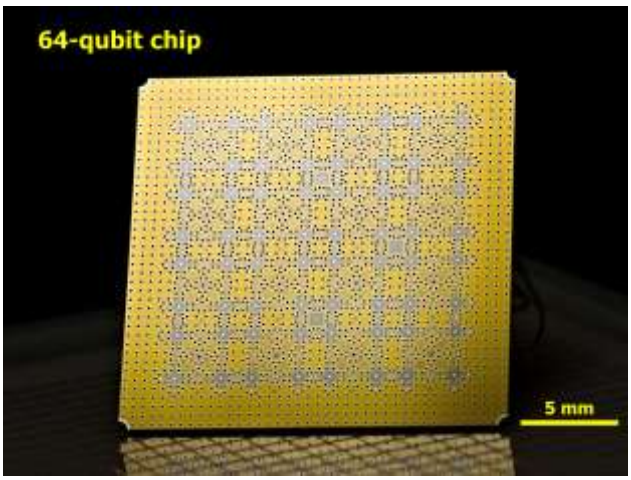

Figure 1: Picture of a 64-qubit superconducting quantum processor chip at RIKEN