The Unexpected Reason Behind Quantum Computer Qubit Decay

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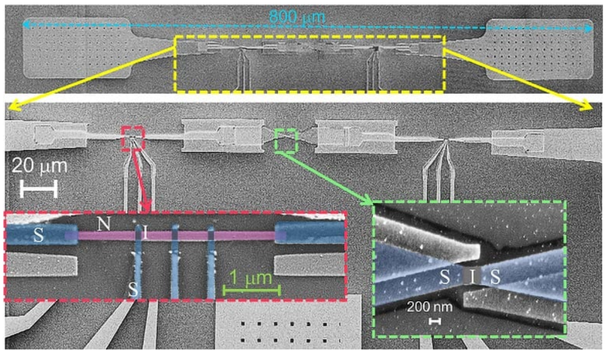
Courtesy of SynEvol

Together with a global team of partners, Aalto University physicists have demonstrated both theoretically and practically that thermal dissipation in the electrical circuit housing the qubit may be used as a direct indicator of superconducting qubit coherence loss.

The fundamental components of qubits, or quantum bits, superconducting Josephson junctions are at the core of the most sophisticated quantum computers and ultrasensitive detectors. These qubits and their circuitry are extremely effective electrical conductors, as their name implies.



Courtesy of SynEvol
Credit: Pico research group/ Aalto University

"How and where does thermal dissipation occur remains a significant unanswered question despite the rapid progress in the creation of high-quality qubits." states Bayan Karimi, the study's first author and a postdoctoral researcher in the Pico research group at Aalto University.

"Our group's proficiency in quantum thermodynamics has allowed us to develop the methods for measuring this loss for a long time," says Jukka Pekola, the professor in charge of the Pico research group at Aalto University.

With the ongoing pursuit of perfecting quantum device technology, physicists are able to gain a deeper understanding of the decay process of their qubits thanks to this fresh data. Longer coherence periods enable qubits to perform more operations in quantum computing, enabling more complicated calculations that are not possible in traditional computing settings.

The Josephson effect, which allows two closely spaced superconducting materials to support a current without an applied voltage, enables the transmission of supercurrents. The investigation has led to the identification of heat radiation that starts at the qubits and travels down the leads as the cause of previously unknown energy loss.

Imagine someone at the beach being warmed by a bonfire; even though the surrounding air is still cold, the individual is still feeling the warmth from the fire. According to Karimi, the same kind of radiation causes the qubit to dissipate.

Scientists who have worked with massive arrays of hundreds of Josephson junctions arranged in a circuit have already observed this loss. One of these intersections would seem to throw the others farther down the line off balance, much like in a game of telephone.

Karimi, Pekola, and the team began by designing their experiments with an array of this many junctions, and then worked their way backward to increasingly basic trials. Their ultimate experimental configuration involved monitoring the impact of varying the voltage at a solitary Josephson junction. They were able to passively measure the very faint radiation emitted from this junction at each phase transition at a wide range of frequencies up to 100 gigahertz by putting an ultrasensitive thermal absorber next to it.

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