Millisecond coherence reached for fluxonium qubit

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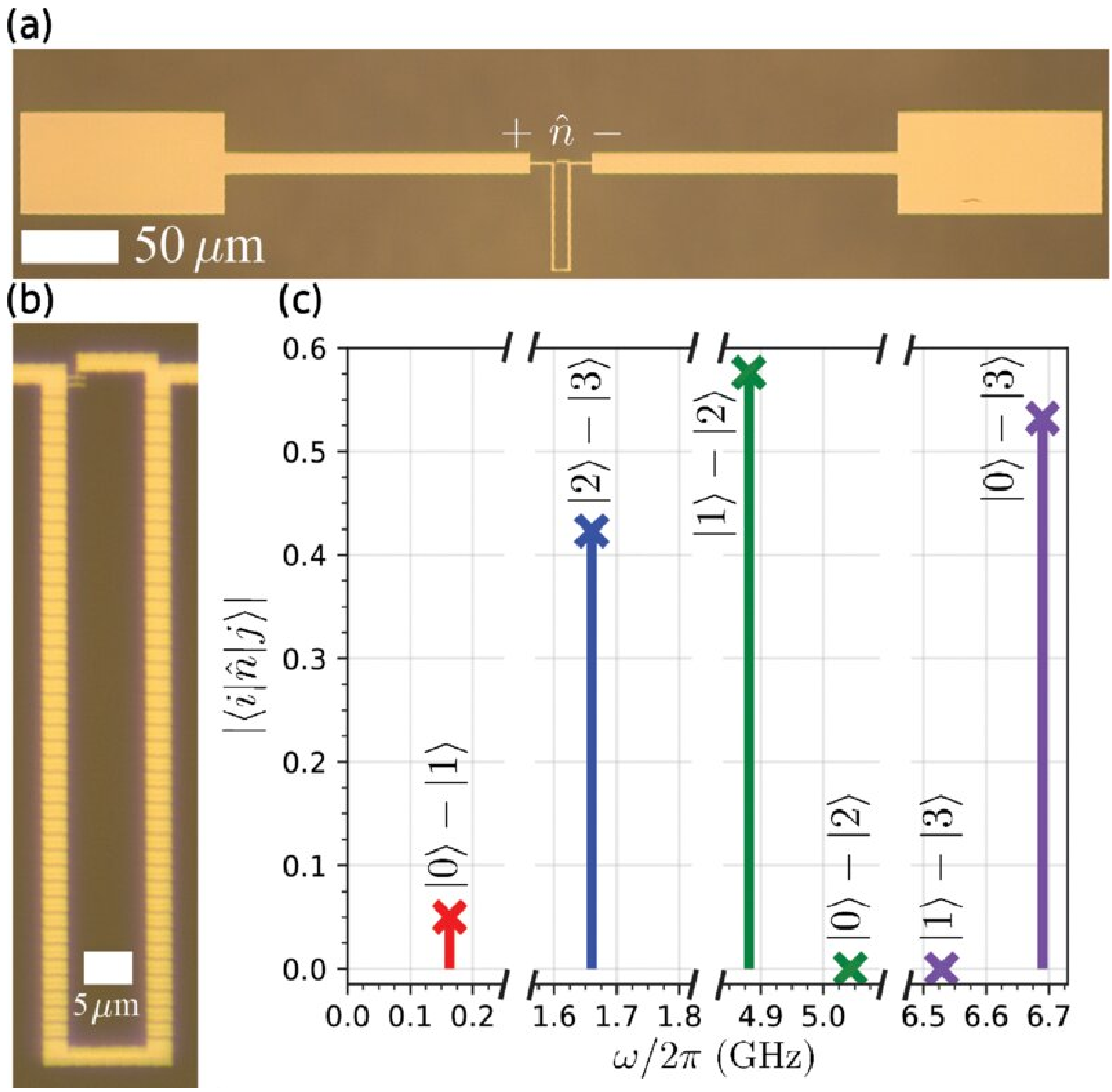

(a) Optical image of the measured device. The antenna electrodes are attached directly to the weak junction of fluxonium, contributing to the total shunting capacitance and coupling the qubit to a copper box readout resonator (not shown). (b) Close up of the fluxonium loop formed by the weak junction (top left corner) and a chain of stronger junctions. (c) Measured frequencies and calculated charge operator n^ matrix elements for transitions between the lowest three energy levels at the half-integer flux bias. Note, the qubit transition $|0\rangle$–$|1\rangle$ is allowed, albeit suppressed in comparison to transition $|1\rangle$–$|2\rangle$, and transitions $|0\rangle$–$|2\rangle$ and $|1\rangle$–$|3\rangle$ are dipole forbidden. Credit: *Physical Review Letters* (2023). DOI: 10.1103/PhysRevLett.130.267001

A team of physicists at the University of Maryland's Joint Quantum Institute and Quantum Materials Center has achieved millisecond coherence while testing the properties of a fluxonium qubit in a quantum circuit. In their study, reported in the journal *Physical Review Letters*, the group made some small changes to the circuit parameters controlling the qubit to increase relaxation times.

As physicists and engineers around the world pursue the goal of building a truly useful quantum computer, some researchers are investigating the amount of time that a qubit can maintain its quantum properties—currently, it is too short, which tends to result in entanglement issues. To that end, research teams have been focusing on the properties of superconducting qubits, such as transmons, which are the type currently used by IBM and Google in their research efforts.

In this new study, the researchers focused their attention on a different superconducting qubit called a fluxonium. Prior research had suggested it may not be suitable for quantum circuit applications due to the short availability time of its quantum properties. But the team has found a way to increase that time by a factor of 10 over previous efforts.

In their work, the research team took a closer look at the relaxation time of the fluxonium—the time during which the qubit moves between states and the time during which the data it stores can be used. They found that if they reduced the operating frequency by optimizing circuit parameters, they could increase the availability (coherence) time of the qubit, bringing its time nearly up to that of transmons, marking them as a possible alternative. More specifically, they found they could increase the coherence time to over 1.43 milliseconds—10 times longer than anyone else has managed to achieve.

The research team also found evidence suggesting that more tweaking could lead to even longer coherence times, possibly making fluxonium a better choice for use in future quantum circuit research efforts.

More information: Aaron Somoroff et al, Millisecond Coherence in a Superconducting Qubit, *Physical Review Letters* (2023). DOI: 10.1103/PhysRevLett.130.267001. On *arXiv*: DOI: 10.48550/arxiv.2103.08578