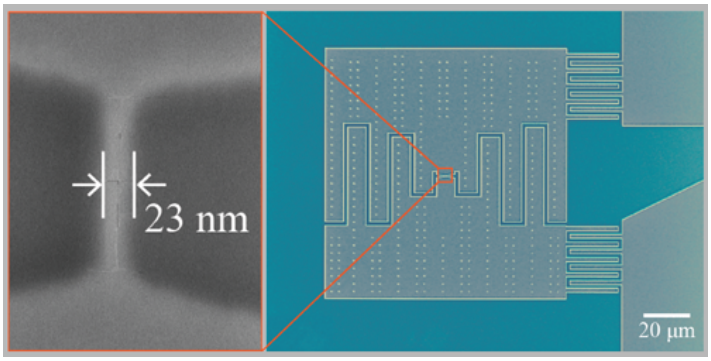
New Amplifier Works in High Magnetic Fields

By switching out a Josephson junction for a nanobridge, researchers have designed a new type of superconducting parametric amplifier that could work in a wider range of experiments.

By **Katie McCormick**

Superconducting parametric amplifiers are useful for many applications, from quantum computing to ultrasensitive searches for new physics. But the standard design based on Josephson junctions has a big drawback: it doesn't work in the strong magnetic fields required by many experiments. Now Mingrui Xu and his colleagues at Yale University have shown that another type of superconducting amplifier—a nanobridge kinetic-inductance parametric amplifier (NKPA)—not only tolerates such fields but can work as well as state-of-the-art Josephson-junction-based amplifiers [**1**].

To understand parametric amplification, consider a child on a swing. By changing the position of their legs as they swing, the child modulates the natural frequency of the pendulum motion. If they do this at a specific frequency—twice the frequency of the motion—they can amplify the oscillation, driving the swing higher and higher. A superconducting parametric amplifier works similarly: a small signal can be amplified by a resonator if the resonator is modulated at twice its natural frequency.



Credit: M. Xu *et al.* [**1**]

While traditional superconducting amplifiers modulate this frequency using a Josephson junction, an NKPA changes the frequency by adjusting the inductance of electrons through a 23-nm-wide nanobridge. While kinetic-inductance amplifiers are not new, this is the first of its kind to achieve a performance comparable to those based on Josephson junctions.

Next, Xu and his colleagues plan to use their NKPA to read out the spin state of an electron in a magnetic field. They think that in the future their amplifiers might be useful as detectors for dark matter or other new particles.

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REFERENCES

1. M. Xu *et al.*, "Magnetic field-resilient quantum-limited parametric amplifier," **PRX Quantum 4, 010322 (2023).**