know why people die. We don't know about the pathophysiology of the disease. We don't know the point of no return."

That could be beginning to change. In 2016, the World Health Organization added Lassa fever to its new list of priority pathogens of epidemic potential, calling for more research. And last week, the recently created Coalition for Epidemic Preparedness Innovations, known as CEPI, awarded its first grant for development of a Lassa fever vaccine to Themis Bioscience in Vienna.

Lassa fever was discovered in 1969, when two missionary nurses died of a mysterious disease in the remote town of Lassa in Borno state in northeastern Nigeria. When a third nurse fell ill, she was evacuated to a hospital in New York City—along with a thermos full of blood and other samples from all three nurses, bound for Yale University's then-new Arbovirus Research Unit. There, a team led by Jordi Casals-Ariet isolated a novel virus from the samples. (He, too, almost died in the process, saved only by an infusion of antibody-rich plasma from the third nurse, who recovered.)

The cause is now known to be an arenavirus, one of a class of rodent-borne pathogens. Its natural reservoir is a multimammate rat, so-called for its rows of mammary glands, that is ubiquitous across West Africa. Cases peak in the dry season, when farmers burn the bushes in preparation for spring planting and rats scurry into houses in search of food. The rodents shed the virus in their urine and droppings, and people contract it by touching contaminated surfaces, inhaling viral particles, or eating contaminated food (including the rats). Like Ebola, the virus can also be spread through contact with bodily fluids from an infected person. Such human-to-human transmission is thought to be rare for Lassa, unlike Ebola, except in hospital settings without proper infection control. However, "The real rate of human-to-human transmission is unknown," says Augustin Augier, secretary general of ALIMA in Paris, which has just launched a Lassa fever research program with the French medical institution INSERM.

No one knows the true incidence of the disease. "Most cases we have found are in places where there are hospitals and labs," Günther says. "There is good reason to assume there are cases that are being overlooked." And because the rat vector lives across a broad swath of the continent, the disease might also be endemic, but unrecognized, outside of West Africa, where it could be responsible for undiagnosed fevers.

Initial symptoms are easily mistaken for malaria or typhoid fever—body aches, sore throat, fever, nausea, diarrhea—before the disease progresses to organ failure, shock, and sometimes internal hemorrhaging. By the time doctors suspect Lassa fever, it's often too late to save the patient. There is no rapid test; accurately diagnosing the disease requires a real-time polymerase chain reaction technique, but just three labs in Nigeria have that capability.

For now, the only treatment is a nonspecific antiviral drug, ribavirin. If it's administered during the first 6 days of the illness, it seems to improve a patient's prognosis, but "no one arrives before day 7," Augier says. Nor is everyone convinced that ribavirin works in Lassa fever, as the only data come from the 1980s, Augier says.

Several potential drugs are on the horizon, in addition to the vaccine. Christian Happi at Redeemer's University in Ede, Nigeria, and the Irrua Specialist Teaching Hospital is developing a rapid diagnostic test with colleagues at Tulane University in New Orleans, Louisiana; the Broad Institute in Cambridge, Massachusetts; and Zalgen, a company in Germantown, Maryland. Happi's group and its partners are also sequencing the virus "around the clock," he says, and trying to figure out whether the genetic changes they have seen could have made it more transmissible or virulent.

"I used to scream and scream that Lassa is important, but no one listened. ... Lassa fever is a disease of the poor."

Christian Happi, Redeemer's University

For Happi, who diagnosed Sierra Leone's first case of Ebola, the new attention to Lassa hasn't come a moment too soon. "I used to scream and scream that Lassa is important, but no one listened," he says. "I wrote so many grants" that were turned down. "Lassa fever is a disease of the poor ... it is confined to a part of West Africa, and it is not viewed as a global threat."

As research scales up, the government and its partners are focusing on training health care workers and providing the basics needed for infection control, as well as educating a frightened public about safety precautions.

Pomarico, who is leading ALIMA's emergency response to the outbreak in the two hardest hit states of Edo and Ondo, hopes cases will subside with the rains and cooler weather, as they usually do. "But this year is different. We are bracing for worst and preparing for the worst." ■

QUANTUM PHYSICS

Vibrations used to talk to quantum circuits

Sound waves could supplant microwaves in controlling quantum computers

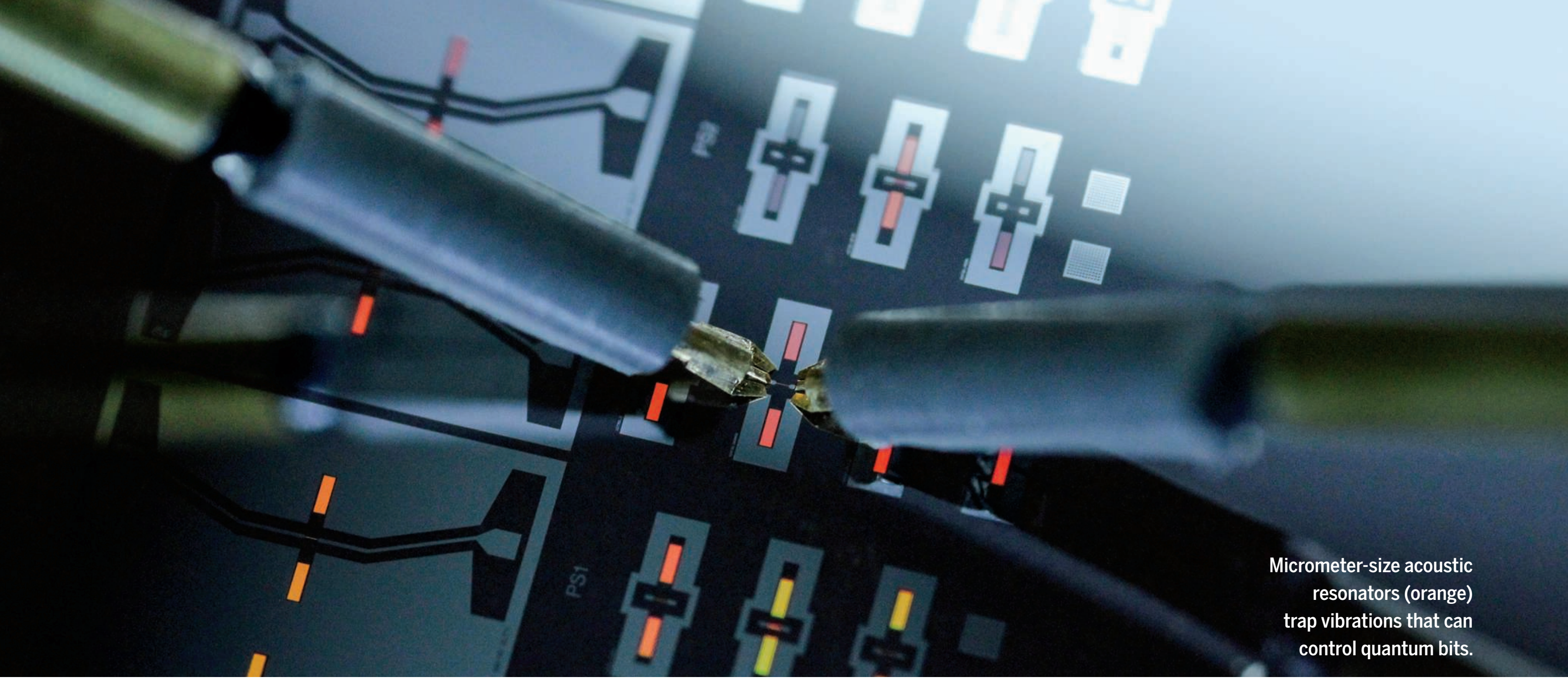
By **Adrian Cho**, *in Los Angeles, California*

For the moment, microwave photons are the keys to many quantum computers: Physicists use them to program, read out, and otherwise manipulate the machines' quantum bits. But microwave technology is bulky, and its quantum states don't last very long. Now, several groups are exploring a new way to talk to a quantum computer: with tiny vibrations, normally carriers of pesky heat and noise.

The budding discipline of quantum acoustics could shake up embryonic quantum computers by miniaturizing technologies and producing longer-lasting quantum memories. "We're right on the cusp" of controlling quantum vibrations, says Andrew Cleland, a physicist at the University of Chicago in Illinois, whose group presented its latest work last week here at the annual March meeting of the American Physical Society.

Whereas an ordinary computer flips bits that can be set to either zero or one, a quantum computer uses qubits that can be set to zero, one, or, bizarrely, zero and one at the same time—potentially enabling huge boosts in speed. Companies such as Google and IBM are racing to demonstrate the superiority of quantum computers for certain tasks (*Science*, 2 December 2016, p. 1090), and many are betting on qubits made of superconducting metal circuits on chips.

To control or read out a superconducting qubit, researchers make it interact with a microwave resonator—typically a strip of metal on the qubit chip or a finger-size cavity surrounding it—which rings with microwave photons the way an organ pipe rings with sound. By adjusting the energy of the qubit, researchers can shuttle its quantum states into the resonator, so that a zero-and-one state of the qubit can be stored as a state of the resonator in which a photon is both present and absent. But some physicists



Micrometer-size acoustic resonators (orange) trap vibrations that can control quantum bits.

PHOTO: KEVIN SATZINGER, CLELAND LAB, UNIVERSITY OF CHICAGO

see advantages to replacing the microwave resonator with a mechanical one that rings with quantized vibrations, or phonons.

That effort may seem daft, as such vibrations constitute heat, which obliterates delicate quantum states. But when working at temperatures near absolute zero, a well-designed acoustic resonator could ring longer than a microwave one does, enabling it to act as a sort of quantum memory, says Robert Schoelkopf, a physicist at Yale University. The vibrations also have wavelengths less than a thousandth as long as microwaves of the same frequency, so the resonators can be far more compact, he says.

First, physicists must learn to control quantum vibrations. They took a first step in 2010, when Cleland, then at the University of California, Santa Barbara (UCSB), siphoned every phonon out of an oscillating cantilever etched from aluminum nitride, leaving it in its least energetic quantum ground state. However, that simple quantum state persisted for just 5 nanoseconds, too little time to put the device into more complex quantum states of motion.

To push further, several groups are manipulating ripples called surface acoustic waves (SAWs), which travel along a material's surface. On top of a microchip, the researchers etch two gratings of metal stripes just micrometers apart. In the gap between the gratings, the researchers trigger a wave by applying a voltage to a comb-shaped device called a transducer, which causes the material to contract. The gratings act as mirrors, reflecting SAWs of particular wavelengths back and forth so that they resonate in the gap. And by connecting the transducer to a superconducting qubit, researchers link its quantum state to the SAWs.

Using that approach, Cleland and Kevin Satzinger, a UCSB graduate student, fashioned a resonator on a lithium niobate chip that rang for up to 150 nanoseconds. They showed they could create any desired combination of zero and one phonons in the resonator, Satzinger told the meeting. "We can watch the energy going back and forth" between qubit and cavity, he says.

Researchers in Schoelkopf's group are focusing not on waves trapped on a chip's surface, but on vibrations traveling through the chip's bulk material. They exploit vibrations that can bounce between the upper and lower surfaces of the half-millimeter-thick chip beneath their qubit.

Using that geometry, the researchers kept vibrations in their sapphire chip ringing for up to 60 microseconds, Yale's Yiwen Chu told the meeting. Moreover, the researchers could feed up to seven quanta of vibration one by one into the resonator, she reported. Making more complex quantum states is "really the next step," Chu says. For example, she says, they might try to put the resonator into a Schrödinger cat state, in which it would contain a macroscopic sound wave, comprising many vibrational quanta, and at the same time be devoid of vibrations.

Acoustic resonators could offer more flexibility in quantum circuit designs. In some circuits, multiple qubits are linked to the same microwave resonator, which acts as a conduit for the qubit interactions. But most microwave cavities can only host photons of a single frequency. In that case, all the qubits must interact with one another in an interconnected tangle, says Konrad Lehnert, a physicist at JILA, an institute run jointly by the University of Colorado in Boulder and the National Institute of Standards and Technology.

In contrast, acoustic resonators can enable qubits to interact with vibrations of a few different, closely spaced frequencies. That should make it possible to tailor the interactions among the qubits, so that, for example, only nearest neighbors interact—desirable for modeling certain abstract quantum systems, Lehnert says. He and his colleagues have taken a step toward such control, JILA's Bradley Moores told the meeting, by showing that they could simultaneously couple a single qubit to SAWs of several frequencies.

Quantum acoustics might also help solve a major problem for emerging quantum technologies. Microwave cables can shuttle information within a quantum computer. To move it to other experiments or distant locations, however, those signals will likely need to be converted from microwaves to optical photons, which can travel great distances in optical fibers. Acoustic waves rippling at microwave frequencies have wavelengths similar to those of optical photons. So in principle, they could serve as a bridge to translate between the two, researchers say, although nobody yet knows exactly how to do it.

Acoustic resonators might even test the bounds of the quantum realm. Quantum theory allows tiny things like atoms or photons to be in two places at once, but nobody has ever seen such behavior in a macroscopic material object. Some theorists argue that a yet-unknown principle, perhaps involving gravity, would prevent it from happening for large objects. But Chu says it might be possible to make her group's sapphire chip simultaneously vibrate in opposite directions. That would put tens of micrograms of material in two slightly different places at the same time—and test whether quantum weirdness extends almost to the human scale. "You don't know until you try." ■

Science

Vibrations used to talk to quantum circuits

Adrian Cho

Science **359** (6381), 1202-1203.
DOI: 10.1126/science.359.6381.1202