Quantum microphone captures extremely weak sound

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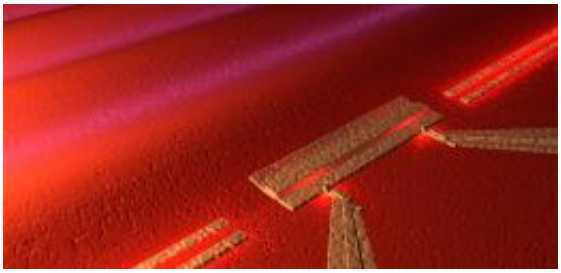

A "quantum microphone" based on a Single Electron Transistor (SET) detects sound waves on a chip surface, so called Surface Acoustic Waves (SAW). The waves make the charge of the atoms underneath the quantum microphon oscillate. Since the quantum microphone is an extremely sensitive charge detector, very low sound levels can be detected. (The size of the waves are exaggerated in the picture). Picture: Philip Krantz, Chalmers

(PhysOrg.com) -- Scientists from Chalmers have demonstrated a new kind of detector for sound at the level of quietness of quantum mechanics. The result offers prospects of a new class of quantum hybrid circuits that mix acoustic elements with electrical ones, and may help illuminate new phenomena of quantum physics. The results have been published in Nature Physics.

The “quantum microphone” is based on a single electron transistor, that is, a transistor where the current passes one electron at a time. The acoustic waves studied by the research team propagate over the surface

of a crystalline microchip, and resemble the ripples formed on a pond when a pebble is thrown into it. The wavelength of the sound is a mere 3 micrometers, but the detector is even smaller, and capable of rapidly sensing the acoustic waves as they pass by.

On the chip surface, the researchers have fabricated a three-millimeter-long echo chamber, and even though the speed of sound on the crystal is ten times higher than in air, the detector shows how sound pulses reflect back and forth between the walls of the chamber, thereby verifying the acoustic nature of the wave.

The detector is sensitive to waves with peak heights of a few percent of a proton diameter, levels so quiet that sound can be governed by quantum law rather than classical mechanics, much in the same way as light.

"The experiment is done on classical acoustic waves, but it shows that we have everything in place to begin studies of proper quantum-acoustics, and nobody has attempted that before", says Martin Gustafsson, PhD student and first author of the article.

Apart from the extreme quietness, the pitch of the waves is too high for us to hear: The frequency of almost 1 gigahertz is 21 octaves above one-lined A. The new detector is the most sensitive in the world for such high-frequency sound.

More information: Read the article in *Nature Physics*: dx.doi.org/10.1038/NPHYS2217

The authors of the article are Martin Gustafsson, Göran Johansson and Per Delsing from Chalmers University of Technology, Gothenburg, Sweden, and Paulo Santos from the Paul Drude Institute, Berlin, Germany. Martin Gustafsson will defend his doctoral thesis in April.

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