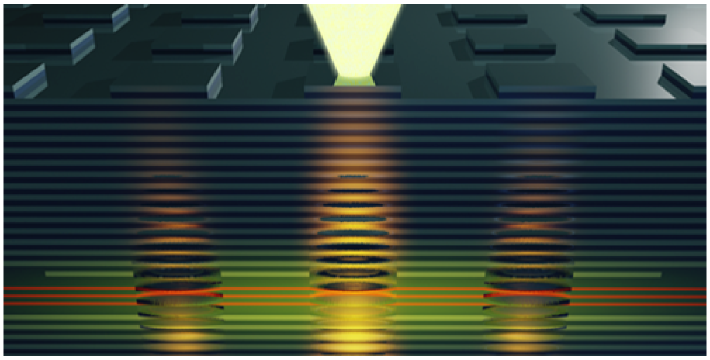
# A Parametric Oscillator for Phonons

**A newly demonstrated device could lead to the creation of entangled pairs of phonons.**

By **Marric Stephens**

Optical parametric oscillators (OPOs) are indispensable in quantum optics, generating entangled photons for quantum communication and creating "squeezed" photon states for precision sensing (see **Focus: Squeezing More from Gravitational-Wave Detectors**). Now, researchers have demonstrated a device that does the same with phonons [**1**]. As well as paving the way for producing entangled phonon pairs and squeezed phonon states, the new optomechanical parametric oscillator could be used for superresolution microscopy and for high-frequency modulation of light sources.

In an OPO, a photon interacts with a nonlinear optical crystal to produce two secondary photons at half the initial frequency. To engineer a parametric oscillator for phonons, Andrés Reynoso and colleagues from the Bariloche Atomic Center, Argentina, and the Paul Drude Institute for Solid State Electronics, Germany, replaced the optical crystal with a 2D array of optomechanical traps with embedded quantum wells. Such traps, or cavities, are resonant with both photon and phonon modes.



Credit: Alexander Kuznetsov/Paul Drude Institute for Solid State Electronics

The team illuminated one of these traps with a laser, exciting in it a high-energy exciton-polariton condensate—a collective state of quasiparticles formed from the repeated absorption and reemission of a photon by the quantum well. Exciton-polaritons then tunneled to neighboring traps, populating them with condensates of lower-energy exciton-polaritons.

During this tunneling process, exciton-polariton pairs with twice the trap's phonon-mode energy generated pairs of phonons. Feedback in the phonon-pair-producing cavities then led to a parametric-amplification effect equivalent to that of a two-phonon laser. The researchers hope to optimize this process to explore the quantum nature of the phonon pairs and to demonstrate mechanical modulation of quantum light sources.

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## REFERENCES


1. A. A. Reynoso *et al.*, "Optomechanical parametric oscillation of a quantum light-fluid lattice," **Phys. Rev. B 105, 195310 (2022).**