

# Optical Lattices with Sound

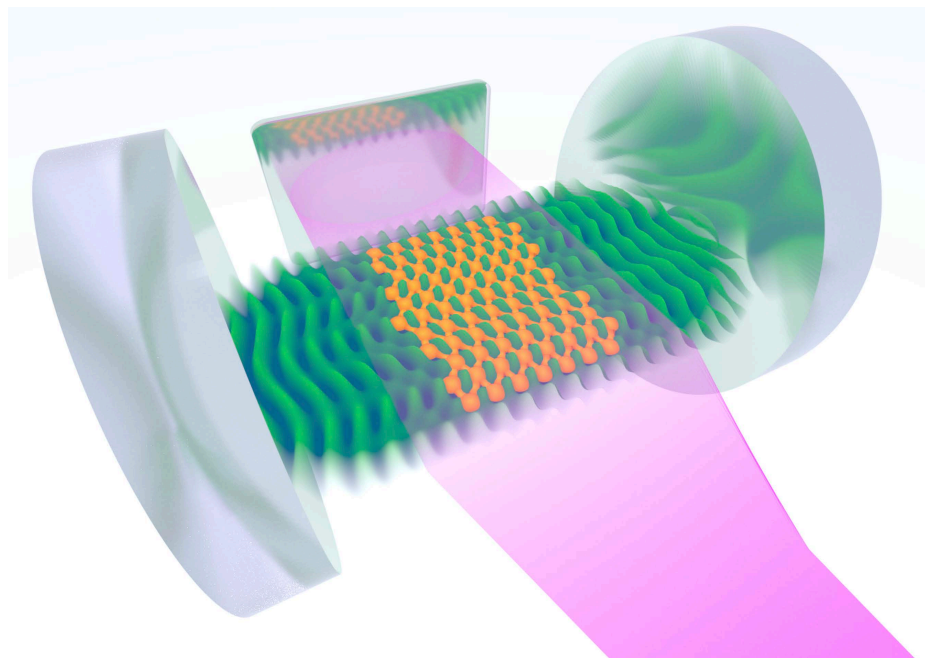


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## Abstract:

Quantized sound waves-phonons-govern the elastic response of crystalline materials, and also play an integral part in determining their thermodynamic properties and electrical response (e.g., by binding electrons into superconducting Cooper pairs). The physics of lattice phonons and elasticity is absent in simulators of quantum solids constructed of neutral atoms in periodic light potentials: unlike real solids, traditional optical lattices are silent because they are infinitely stiff. Optical-lattice realizations of crystals therefore lack some of the central dynamical degrees of freedom that determine the low-temperature properties of real materials. We will discuss our creation of an optical lattice with phonon modes using a Bose-Einstein condensate (BEC) coupled to a confocal optical resonator. Playing the role of an active quantum gas microscope, the multimode cavity QED system both images the phonons and induces the crystallization that supports phonons via short-range, photon-mediated atom-atom interactions. Our results pave the way for exploring the rich physics of elasticity in quantum solids.



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